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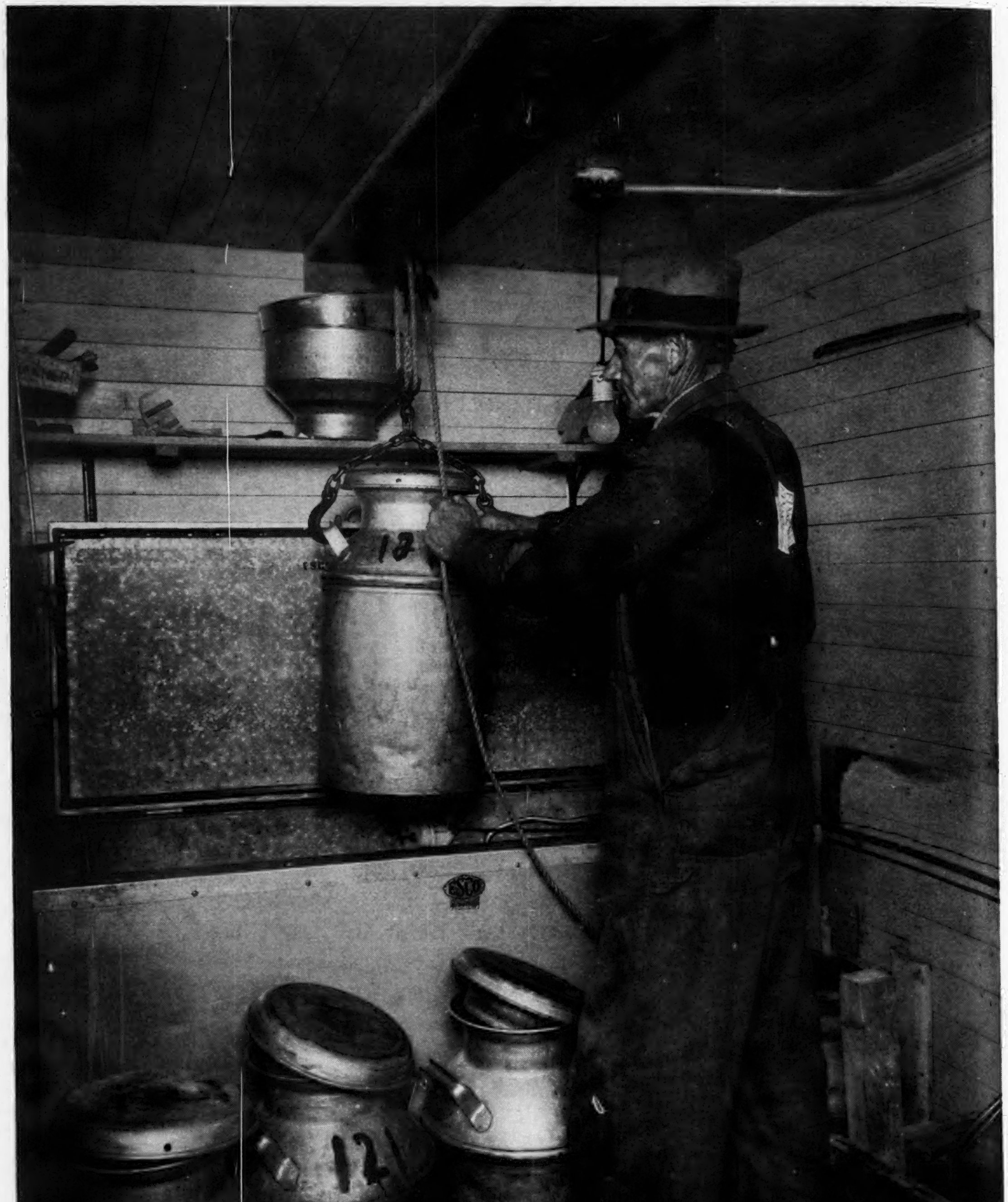

Refrigeration

PERISHABLE human foods require accurate temperature control and other sanitary precautions at the point of production to insure a safe, high-quality product reaching the consumer. Refrigeration at the farm puts the products in condition to reach more distant markets and to command price premiums for quality. Insulation, refrigeration, air-conditioning, and temperature control instruments are also beginning to be used to insure a favorable environment for farm plants and animals, and for storage and curing. Engineering these facilities into farm structural, mechanical, electrical, and operating organization for low-cost, high-quality production is an agricultural engineering job.

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Technology of Rural Electrification

AN UNDERCURRENT of feeling in the Rural Electric Division of the American Society of Agricultural Engineers favors increased emphasis, in its programs, on the technology of rural electrification.

Study of electricity antedates Ben Franklin. Its phenomena command the interest of theoretical physicists, engineers, experimenters, manufacturers, utilities, merchants, contractors, tradesmen, tinkerers, and even playing children. Its applications to life scarcely know any geographic, occupational, or financial boundaries.

At what level then, and in what manner, should a group of agricultural engineers interest themselves in the application of electricity to agriculture?

Let us eliminate all subprofessional interest, except as agricultural engineers might help contractors and tradesmen for example, to improve their service to farmers.

Let us admit, too, that few agricultural engineers are both qualified by training and free in employment to pursue the mysteries of electricity through abstract physics and mathematics to evolve new laws and principles which might eventually find applications in farming. Such as are qualified and free to do so, might well apply themselves in this direction, but they will probably not produce much program material for the Rural Electric Division in the near future.

Let us eliminate also the engineering initially done and currently in progress for urban applications and living conveniences which need little or no special engineering adaptation to meet farm requirements. These include current generation for power lines, motor design, lights for seeing, storage and dry batteries, and numerous domestic appliances. And for the purpose of this discussion, let us eliminate the legitimate but less technical interests of agricultural engineers in extension, sales, and possibly service, which have up to now received the lion's share of attention in Rural Electric Division programs.

What is left in the technology of electricity and electric applications, in which agricultural engineers might stimulate interest and progress through their meeting programs?

There is research and development work, naturally cooperative with biologists, on the influences and practical applications of electricity and electrical effects on biological activity. There is even the possibility of deeper research into the electrical factors in soil reactions, plant and animal cell life, and photosynthesis, with a view to the possibility of effecting increased control and improved quality and efficiency of biological production.

There is engineering development work on new equipment and adaptations of equipment and materials to utilize the phenomena of alternating and direct current and possibly static electricity, through magnetism, vibrations, discharges, and other effects, in old and new farm operations and operation controls.

Safety considerations, dependability, and use economy of new equipment must pass through stages of technological development before they become material for extension work.

Specifically, the present setup of technical committees in the Rural Electric Division suggests some recognized present technical problems which might provide ample material for a start toward more technical programs. These include committees on applying fractional horsepower electric motors to farm equipment, applying integral horsepower electric motors to farm equipment, electric fencing, electric heat in the farm dairy, electric heat in plant production, electric heat in poultry and farm animal production, electric light for insect and bacteria control, electric light in plant production, electric refrigeration of farm products, electric refrigeration in the farm home, and farm and home wiring. These committees presumably will have, or know where to get, program material and speakers on their respective technological subject matter.

Farm Product Use Values

CAUSE for reflection on the depth of agricultural engineering research into the material and force relationships of soils and other factors in crop production is provided in the paper by G. Douglas Jones appearing elsewhere in this issue.

From Mr. Jones point of view the use value of farm products needs more detailed study, even to the extent of determining the functions of the rarer food elements in human nutrition. Use value studies would naturally point back to soil constituents, their availability, their assimilation by plants and influence on plant growth, and the engineering controls which might be applied to biologic production to increase the use value of the product to man.

In other words, he is not satisfied with a nutritional science limited to studying generalized functions of proteins, carbohydrates, and fats; with a soil chemistry limited to nitrogen, potassium, and phosphorus; with a soil physics limited to hardness, particle size, and water relationships; with a largely qualitative plant science; with two-dimensional farming, or with an agricultural engineering devoted to mere technical improvement of the tool and shelter expedients of prehistoric man. And he is far from alone in his viewpoint.

What of the score of rarer elements in human chemistry? Is their importance to be estimated and discounted on a flat-rate-per-pound basis? Some may be poisons, others essential catalyzers. What of their presence in and exhaustion from farm lands? Can a farm crop, or even a domestic animal, pasture at will for a balanced diet? What of their availability to and influence on plant growth, in their uncombined state and in their compounds and mixtures of compounds, and in polymeric forms? What of the physical or structural organization of materials in soils, plants, and animals? What of the energy transfers from sunlight through photosynthesis, electrostatics, and osmosis, to complex molecules of organic chemicals? What of the interrelationships between chemical raw materials, physical environment, plant structure, and changes of form of energy in utilizing the hereditary potentialities of living cells to produce materials, with a view to their ultimate use value to man?

Experiments in deep tillage have indicated improvements in farm production within easy reach but not commonly grasped. They also indicate many blanks in our knowledge of how and why a plant grows, and how it can be helped to grow. If they result in developing more mere rule-of-thumb practices for farmers, they will mark a fal-

tering, half-hearted step in progress. If they are attacked in the spirit of true scientific research, they should lead toward the ultimate goal of maximum human utilization of the biological "ten talents" supplied to mankind.

It is not within the province of agricultural engineers to attempt to develop all the scientific facts which might be useful to them in this connection. It is within their province to let other scientists know that agricultural engineers want more detailed information on the characteristics which make various plants useful to man, together with more detailed information on how plants acquire these characteristics, in order that more and better engineering controls over biological production conditions may be developed for farm application and increased farm productivity of genuine use values.

Research Viewpoints

"WE HEAR much of surpluses, of idle acres, and idle men. This abundance that we should work for grows out of new uses for farm crops, new crops, new plants, new methods and new materials. Through research, the great truths of science are being put directly to work for the man on the farm with his surplus of cotton, corn or wheat, and other commodities so that markets may be enlarged, prices stabilized, and unemployment reduced.

"Research is the new ally of the American farmer. For a long time scientists, hidden away in small corners with their deeds unsung, have been exploring the basic facts of all organic material. They call it fundamental research. That is the type where the worker is constantly busy with countless test tubes, glass jars, mysterious measuring instruments and gadgets of all sorts, spending long hours at their tasks.

"To the average person their work has always seemed unimportant. However, in recent years their hard-earned facts have been correlated and are bearing fruit. Out of them have come a host of new industrial uses. The raw materials for these products have come from the farm, a constant and ever renewable source of supply. The facts of science and the crops of the farm have been put to work in industry.

"These constant efforts give the outstanding fact that we are today using the crops of over forty million acres in industrial processes. There are no reasons why this new market for farm crops will not be doubled and tripled.

"As the program moves forward it is one of orderly progress. Science can work successfully in no other way. It must be governed by the factors of patience, and profitable markets for both the manufactured goods, and for the farmer who grows the raw materials."—*From a recent radio address by Louis J. Tabor, Master, The National Grange.*

* * *

"Faraday, when he made his great discovery (of electromagnetic induction), was not trying to find out what the public wanted, nor how to give it to them. Not even Faraday could have conceived an electric power plant with its far-flung transmission lines bringing cheap and convenient power, light, and heat to factory and home. Faraday had only one object—the discovery of new scientific facts. He was seeking to push the boundaries of mankind's narrow field of knowledge farther into the great unknown.

"That is what Faraday meant by research, and it is with the same meaning I use the word today. I do not mean that all research in the physical sciences is of the fundamental nature of Faraday's. In our laboratory we recognize and conduct two different types of researches—one which we call fundamental or extensive research, which, like that of Faraday, seeks new generic facts or principles, an extension of our range of knowledge, with no immediate practical objective; the other, which we call intensive research, or research in applied science, which seeks new facts regarding the application of scientific knowledge for specific practical ends.

"In all industrial research laboratories, including ours, the latter type of research predominates. In the majority of them it is the only form of research conducted. It is a well established activity in nearly every industry, and at this day needs no justification. It is through such researches that continual progress is made in producing better goods at lower cost. It enables the manufacturer to maintain profits, while continually reducing his selling prices. By giving the public more goods, better goods, and less expensive goods, it directly raises the standard of living.

"Francis Bacon, in his book "The New Atlantis," forecast a future world such as might be created by the advance of science. It was a remarkable prophecy. Out of twenty-two new developments, the suggestion of which must have been startling enough in his day, all but one have come substantially into being. It is interesting to note which of the new developments of the past three hundred years Bacon was able to foresee, and which lay beyond the grasp of even his powerful imagination. When this is done, the reason becomes apparent why one thing was predictable and another not.

"To foresee the possible forthcoming of the automobile, the submarine and the airplane was marvelous indeed, but Bacon was familiar with carriages, fish, and birds, so he was able to conceive the possibilities of a carriage which would need no horse, of a boat which would move under water like a fish, and of a device which would enable man to soar through the air like a bird. All his prophecies were based on familiar things.

"In his day nothing was known of electro-magnetic induction, nor of electro-magnetic radiations, nor of photochemical reactions, nor bacteriology, so he did not and could not predict the telephone, electric power transmission, electric lighting, X-rays, radio, photography, or antisepsis. These and many more developments, which have come to make our lives richer, safer, and more comfortable, were beyond the reach of human thought until the discovery of new and fundamental scientific facts revealed the possibility of achieving them.

"Research in the applications of science improves and finds new applications for existing things, but it is research in the fundamental principles of science which opens up fields which are wholly new.

"But fundamental research is admittedly a gamble as far as practical results are concerned. It is an exploration of unknown territory, where no one can predict whether anything of marketable value will be found, nor, if it is, what its nature will be. So why should industry embark on so uncertain an enterprise?

"The answer is that it has been found in the long run to pay. Any research may draw a blank, but if it does pay, the returns are likely to be very great.

"Of course not all fundamental research yields practical results. Langmuir's recent work, extending over many years, although it has opened up a new branch of chemistry and brought him a Nobel prize, has as yet brought us nothing with market value. But we have not yet begun to worry. He has developed a marvelous technique by means of which he can measure differences of film thickness of only a hundred millionth of an inch and can detect substances in solution with a concentration of only one part in a billion.

(Continued on page 53)

Mechanizing Forage Crop Handling

By F. W. Duffee

THE PROCESS of making hay is frequently alluded to in the Bible. From primitive times until quite recently, there has been no material change in the process of making hay. Apparently the idea of mowing grass by horse power was conceived in America, and the first patent along this line was granted Peter Gaillard, December 4, 1812.

By about 1870, a mower closely resembling our present mower was coming into general use, the steel dump rake quickly followed, and later the side rake. About 1874 the Keystone Manufacturing Company began the development of the carrier-type hay loader, and a little later Deere and Mansur brought out the push-bar type.

The hay fork operating on a truck was first developed in 1869, and by 1885 the steel track had come into use. In 1886 P. A. Myers patented a track formed of two T-bars placed side by side and clamped together.

Horse-power-operated hay presses along the lines of modern construction were invented about 1872 and about 1884 steam power presses were introduced.

This brief historical review of the development of haying machinery indicates that our modern types had their inception about 1870 to 1885, or upwards of 60 years ago. During this period of 60 years there has been no further general development of methods, although there has been marked development of design details, as well as materials of construction.

During this same period we have seen all other major field operations completely mechanized, the machines developed to a high degree of efficiency, and their use quite widely adopted by farmers. All along the line mechanical power and new machines are rapidly taking the place of methods that require large amounts of hand labor, but haymaking on most farms still requires hard hand labor in loading, and hand pitching in the field and in mowing away.

Hay is a major crop too, occupying one acre out of about every $4\frac{1}{2}$ acres of crop land in the United States and grown from the Atlantic to the Pacific and from the Gulf to the Canadian border.

The field baler has entered the picture and has found considerable acceptance in the commercial hay-growing

(Upper left) Experimental field hay chopper built in 1929. (Upper right) Same machine improved and equipped with carrier elevator. (Lower left) One man picking up, chopping, and loading hay at a rate as high as 10.7 tons per hour. This machine represented the first thoroughly practical field hay chopper. It incorporated straight-line motion from windrow through cutter head, is compact, and easily handled. This model is too large and expensive to be practical for the average farmer. (Lower right) The same machine, with conveyor elevator, picking up and chopping green alfalfa for silage. In practice a cutter bar would be used on the machine for this operation to combine mowing, chopping, and loading

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 30, 1938.

Author: Professor and head of the agricultural engineering department, University of Wisconsin. Fellow A.S.A.E.

areas; the push rake and stacker work well for outdoor stacking; however, the latter does not seem to be adapted to the majority of farms, especially through the Middle West and East, where all or nearly all the hay grown is stored in the barn. The field baler does not seem to be well adapted to the areas where the hay is fed on the farm where grown, principally because there is still much hard work required in handling bales, and also because other methods show much greater promise of lower machine and labor costs. The feeding of baled hay is not popular in many cases due to the difficulty of breaking up the bales.

The method of making silage out of forage crops is now being used by many farmers, and its use is spreading rapidly, so a new problem confronts us.

This process seems to offer the best and most practical method available to the average farmer in the humid regions, whereby he can be reasonably sure of saving the crop after it is grown. Losses due to rain, dew, and bleaching when making hay are really alarming. In some cases, the crop is almost, if not entirely, a total loss.

While there are certain advantages of grass silage from the feeding standpoint, it seems that most farmers consider the principal advantage to be the ability to save the crop after it is grown. The practice seems to be to make silage when they can't make hay. The soil-saving or erosion-control factor is also important.

Handling green forage with our present mower–loader equipment is still harder work than harvesting dry hay; also all of the material is usually hand pitched into the cutter, which is indeed hard work.

At the Wisconsin agricultural experiment station, we began to consider this problem of mechanized haymaking particularly as applied to middle western and eastern farms about 1925, and in 1927 began some crude field experiments.

The method that seemed to show promise was that of chopping the hay in the field directly from the windrow, and at the barn to blow it into the mow. With this method all or practically all hand work was eliminated in the field, and at the barn hand work could be eliminated by dumping the load or sliding it off by power into the fan, although hand-pitching the chopped hay into the fan is much lighter work than handling long hay. Also the work was outdoors rather than in a hot, dusty mow inside.

The J. I. Case Company built an experimental machine for us which was first used in the season of 1929, and while the general layout of this machine did not follow our suggestions, it did demonstrate the feasibility of the method. During the following two or three years, this machine was modified until fairly satisfactory performance was secured.

In 1936 the Fox River Tractor Company brought out a machine which was successful. It incorporated straight-line movement from the windrow to the cutter head, and was compact and easily handled. With suitable hauling equipment, one man can pick up, chop, and load at the rate of about eleven tons per hour. Where the wagon is not hitched to the cutter, another man would be required. While I have no data relative to time lost in changing from one wagon to another, this should not exceed 50 per cent of the total time, thus giving an hourly rate of cutting of about 5 tons per hour.

In order to show more clearly the possibilities of this method, I am taking the liberty of comparing it with the field baler, and with mowing whole hay, and I offer this purely from a constructive point of view.

Iowa Bulletin No. 322, by Davidson and Carter, published in 1934 and entitled "Harvesting Alfalfa with a Pick-up Baler", states "The maximum capacity of 5.1 tons was attained in only one instance for 6 min through a series of large charges." The variation was at an hourly rate of from 1.6 to 5.1 tons. "The actual capacity for the season was 1.59 tons per hour, or 34 per cent of the theoretical capacity." Using the same percentage (34 per cent) which I believe is too low for the field harvester, would give it a capacity of 3.7 tons per hour.

The crew for a pick-up baler will consist of 3 or 4 men, and additional help is required to load the bales. The Iowa bulletin gives two additional men (the minimum crew) when a trailer was hitched to the baler and the bales pushed direct from the baler onto the trailer. Thus a minimum crew required to bale and load 1.59 tons per hour is 5 or 6 men, while with the field chopper the minimum crew is one man chopping 3.7 tons per hour. The lowest total given for baling and loading with the field baler is 3.64 man-hours per ton, and, from the above, it is 0.27 man-hours per ton for the field chopper, a difference of over 13 to 1. If two men are used with the field chopper, the ratio is 6½ to 1 in favor of the chopper.

I quote further from the Iowa bulletin: "It is to be noted that there are no arduous tasks connected with the operation of the baler. . . . . The labor required to collect and haul the bales to storage is great."

At the barn at least two men will be required for storing bales, while one man can unload chopped hay certainly as fast if not faster, if some method of dumping is used, or two men can undoubtedly fork off a load of chopped hay as fast and more easily than two men can store bales.

Hamlin and Bullock report[1] on a survey of 100 farms in 22 states that on the average it requires 2.26 man-hours to load and mow one ton of whole hay, of which 1.35 man-hours are required at the barn, thus leaving 0.91 man-hours for loading. Compare this with 0.27 man-hours for the field chopper.

They report on chopped hay, (chopped at the barn) as follows: Man-hours for storing, 0.53; and total man-hours for loading and storing, 1.39.

The field hay harvester as built at present is too large and too expensive for the ordinary farmer, but I see no serious or insurmountable obstacle in the way of a small, light machine.

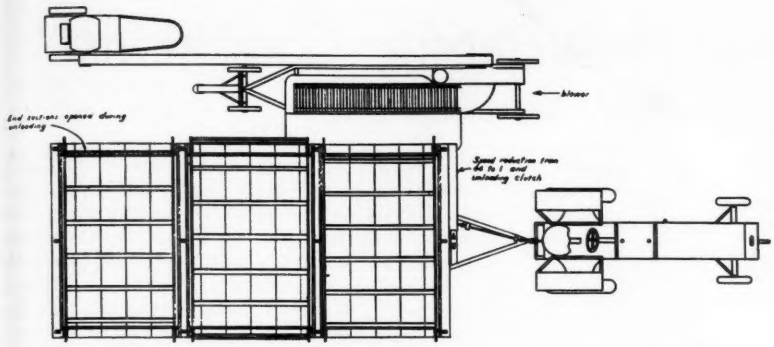
The harvesting of forage for silage is greatly facilitated by such a machine. In a short trial with soybeans, two men unloaded field-chopped soybeans just twice as fast and much easier than whole beans.

I wish to propose the general specifications of a machine for harvesting forage, green or dry, that will fit the average farmer's tractor as well as his pocketbook. I wish to use as a comparison a certain make of baby combine that has a 40-in cut and retails at present for $345.00 f.o.b. factory. I believe the comparison is appropriate both from a structural and a functional point of view.

The hay harvester will cut the same width of swath, 40 in, using essentially the same cutter bar, reel, and draper. The same frame, wheels, tires, power-take-off shaft, and gearing will be used. The chopping cylinder will undoubtedly have to be heavier and more expensive.

We will eliminate the straw rack, grain pan, cleaning shoe, shoe fan, augers, elevators, and grain bin, in fact all of the separator and its fittings, and in their place substitute an elevator which certainly should cost enough less than the separator to offset the extra cost of the cutting head. As to whether the elevator should be a blower or carrier would depend primarily on cost; personally, I prefer the

[1]"Costs of Storing Chopped and Whole Hay," AGRICULTURAL ENGINEERING, Vol. 14, No. 6 (June 1933).



A suggested development for unloading chopped hay or silage. The wagon or trailer bed is divided into three sections crosswise of the unit. Endless conveyors similar to those used in manure spreaders, and driven from the power take-off of the tractor, convey the load to the elevating fan. The sections are unloaded one at a time. This might be used for hauling and unloading small grain and corn, as well as dry chopped hay, green forage for silage, and corn for silage

carrier, but probably the blower would be cheaper. If possible, the machine should be convertible.

For harvesting dry hay, the knife would be removed and a pick-up mechanism attached.

A machine of this size would not have the capacity of the machine discussed above, but should, I believe, meet the requirements of the average farm. Assuming a yield of two tons of dry hay per acre, and that such a machine will handle one 5-ft swath, it should cut one ton in approximately 22 min with the tractor traveling 2¼ mph.

In making silage, a machine of this size should cover 5 to 8 acres per day. Thus a 40-acre field of alfalfa could be harvested in 5 to 8 days.

The field chopper would eliminate the hay loader and hay fork equipment in making dry hay a saving of at least $150.00 to be offset against the cost of the harvester and a fan at the barn.

In making silage, it would eliminate the mower, the rake, and the loader in the field, and the ensilage cutter would be replaced by a less expensive blower at the silo.

At the present time, the molasses treatment for forage crop silage is most popular. The first method suggested for applying molasses to the silage was to mix the molasses with about an equal part of water, stir this thoroughly until uniformly mixed or diluted; then the diluted molasses could be applied in either of two ways. One was to allow it to run by gravity into the cutter and the other was to pump the diluted molasses up into the silo where it could be sprayed onto the chopped forage by the man in the silo.

The method has several disadvantages. Considerable time is required to dilute the molasses, particularly in cool weather, and another and probably more serious disadvantage is that the addition of more water to the silage aggravates an already serious nuisance if not a serious disadvantage, and that is the seepage from the silo. Another disadvantage is the trouble of elevating several barrels of molasses up onto a platform and into a mixing tank if the gravity method of supplying the diluted molasses to the cutter is used.

A method that is now being adopted by a number of manufacturers is that of mounting a small rotary pump directly on the cutter and then to pump the undiluted molasses directly from the barrel into the cutter. A ¾ or ½-in pump is commonly used. In any case, the connections must be stepped up to at least ¾ or 1 in immediately outside the pump in order to reduce the friction losses due to the viscous condition of the molasses.

The molasses may be applied a number of places. The better practice seems to be to apply it to the material between the upper feed roll and knives, or to pump it into the fan housing near the center of the housing. In any case, it is desirable to devise some means of positive and automatic stoppage of the molasses supply when the cutter is running empty; otherwise a serious clogging will result when feeding is resumed. Two methods at present are used. In one case, a valve installed between the pump and the cutter is operated by the upper feed roll. The adjustment is so arranged that the valve is closed when the feed roll is all the way down or in the lowest position when the cutter is running empty. The lever mechanism between the feed roll and the valve is usually adjustable so that the rate of flow can be varied and thus the amount applied to the forage properly regulated. It has the further advantage of applying the molasses more or less proportionately to the feeding.

Shortly after developing this method of control, we discovered that the J. I. Case Company hold a patent that would cover this situation, but this patent expires sometime in 1939. At the present time, manufacturers that have used this method have made satisfactory arrangements with the Case Company to use the system.

The other method of stopping the molasses flow when the cutter is running empty, is to install a clutch on the molasses pump which is operated by the upper feed roll in such a way that the pump stops when the feed roll is down and starts as soon as the feed roll has lifted an inch or so.

The most convenient method of measuring the amount of molasses applied is to place the molasses barrel on a small platform scale and weigh it at the beginning and end of each load. A suction hose at least 1 in in diameter, preferably 1¼ in, is used between the pump and the drum.

That farmers are interested in the field chopper is evidenced by the following incident: A magazine with a large circulation throughout the Middle West recently ran a short story which among other things referred very briefly to this method of making hay. Over 7000 inquiries came in as a result of the story.

In order to completely mechanize the operation where the volume of hay handled warrants it, a power take-off driven unloading mechanism for the wagon or trailer is suggested in the accompanying drawing. A method somewhat similar to this has been used for several years by a few farmers, and in actual practice corn silage has been unloaded at an average rate of 11.11 tons per hour. One farmer says that this method together with the field ensilage harvester has changed silage making from the hardest to one of the easiest jobs on his farm.

As to whether or not the field chopper is the answer to the question of mechanizing haying operations, only time will tell, but I am convinced that the time has come for agricultural engineers and the implement industry to give consideration to this problem, and out of such study and effort some better method I am sure can be evolved.

Let us finish the job of mechanizing all field operations and not leave the farmer with this one peak man-labor load.

Paint to Meet Farm Service Conditions

By W. O. Gairns

FARM PAINTING is comparable to industrial maintenance painting in that the utilitarian or protection motive is, in the majority of cases, the predominant consideration. The efficient operator of a "farm plant" like the efficient operator of an industrial plant, is interested in the most he can get from his maintenance dollar in the form of lasting protection for his property and equipment, always coupled, of course, with good appearance.

Aluminum paint has many characteristics, some of them quite unique, to recommend it for farm use. It provides one kind of material which can be used satisfactorily on practically any paintable surface. It gives an equally good account of itself on steel, wood, brick, concrete, plaster, wallboard, asphalt roofing, galvanized iron, and even canvas.

It has durability that equals or betters that of most darker colored paints and is superior to that of other paints of equally light color. Our company's research and test program on aluminum paint during the past 15 or 20 years has been aimed principally at improving aluminum paint and the service it can render. In all of our testing programs, including panel tests, test fences, and field tests on many buildings, we have yet to find another material which, in two-coat work on wood, will give better protection and service than will two coats of a high-quality, properly constituted aluminum paint. It is also notable that this advantage in durability in favor of aluminum paint becomes more pronounced when comparisons are made on the cheaper grades and species of lumber, which are generally conceded to be less paintable. It is these grades and species which are probably most widely used in the construction of service buildings on the farm.

Used as a primer under other paints on houses it will contribute durability and satisfaction by adding to the life of the entire job. Its use as a finish coat on houses is limited, but it is frequently applied to barns and other outbuildings in this manner.

REFLECTIVE PROPERTIES OF ALUMINUM PAINT

Another valuable characteristic of aluminum paint is its capacity to reflect light and heat. Its light-reflecting property makes it an excellent paint for use in interiors where painting is required or considered justified, because it achieves practically its maximum reflectivity in one coat, whereas other light-colored paints of comparable durability generally require two or more coats to achieve a like result. Aluminum paint will hide any under color, even black, completely in one coat. Because of its high moisture-proofing power and its ability to withstand washing, as well as constant exposure to steam, fumes, and other corrosive agencies, it is widely used in dairies, creameries, and similar plants and buildings.

Its heat-reflecting power is generally given as being in the neighborhood of 70 per cent. An aluminum-painted surface will absorb solar heat about 28 per cent as fast as a black surface and about 50 per cent as fast as a red-painted surface. Observations made in this climate have shown variations of as high as 40 to 45 F (degrees Fahrenheit) between the surface temperatures of aluminum-painted areas and unpainted areas, side by side, on the same roof, and under the same conditions. Painting the surface of a roof with aluminum paint may reduce the rate of flow of heat through the roof by as much as 50 per cent. Of course, if the roof is well insulated, the rate of flow will be small and a 50 per cent reduction would not affect interior temperatures materially. But if the roof is not insulated, the effect becomes appreciable and often measurable.

I would like to emphasize here that the use of aluminum paint on roofs is not confined to metal roofs. It can be and is used on all other types of roofing with comparable thermal effect. And when used over asphalt and bituminous roofing materials it adds measurably to their life and lasting qualities by protecting them from the sunlight which is the primary cause of their oxidation, embrittlement, and final failure.

The use of aluminum paint for the repainting of metal roofs and buildings is finding ready acceptance. However, I submit to you the suggestion that most of this painting is being done too late. The average farmer puts on a galvanized iron roof, for example, and then forgets its maintenance, until the galvanizing fails. Then he may make an effort to paint it, or he may let it go until the sheets rust through and then replace them.

PAINTING TO PROTECT GALVANIZED SURFACES

Would it not be more economical in the long run, to let the new galvanizing weather for 3 to 6 mo to render it easily paintable, and then paint it while the galvanizing is still sound? The wear is then thrown on the paint, which is cheap and easily renewed. The galvanizing remains protected and in turn can continue to do its job of protecting the steel almost indefinitely. It stops the gap between repaintings when the original paint coating's service life is ended. That this system is sound is demonstrated by its growing use in industrial fields.

When a rusty roof or rusty steel of any kind is to be repainted (and this would include most machinery and equipment), the most important part of the repainting job is the cleaning and preparation of the surface to receive paint. The best of materials may fail to do their job if robbed of the chance by slip-shod or inadequate surface preparation. All old loose material in the form of dirt, scale, rust, and loose paint should be thoroughly removed by scraping and scratch brushing with wire brushes. Grease and oil should be removed by washing with gasoline or naphtha. Any area that had rusted should be given a coat of good grade inhibitive priming paint. If earlier failure has been general a full primer coat rather than a spot coat is recommended. The time between cleaning and priming should be held to a minimum. Paint should go on the same day the cleaning is done, if possible. The primer, when dry, should be followed by two coats of aluminum paint, allowing at least 48 hr drying time between coats. Such a paint job will give long and satisfactory service. Three-coat work of this kind has stood for as long as eleven years on large bridges and has been in good shape for repainting at the end of that time. Service on a roof is much more severe, but I would not consider an expectation of 5 or 6 yr as asking too much. What one could expect on a corn plow or a hay loader (Continued on page 54)

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 29, 1938.

Author: Aluminum Company of America.

Making Electric Service Available to Farmers

By E. C. Easter

THE INTEREST of our company in the extension of electric service to rural areas and the low average farm income in Alabama made it necessary many years ago to consider the factors essential to progress in this development. When the company built its first rural line in 1920, it wanted to build rural lines generally throughout the state, but at that time there was no general interest in rural electrification and little information available on the uses of electric service in the home and on the farm. The average urban citizen considered electricity only as a good means of lighting, and the average farmer was familiar with electricity only sufficiently to be afraid of it.

It was apparent that electric service, in order to make its extension economically feasible, would have to be of more value to the rural and farm customer than household lighting alone. Also, it was apparent that, to avoid being a burden to the limited farm income and a retarding influence upon the development of rural areas, the uses of electric service would have to be not only economical and satisfactory to the rural and farm customers for the conveniences in their homes, but it would have to at least pay its own way through increased income and reduced operating expenses.

Obviously rural electrification was primarily an agricultural development, and the uses of electric service by rural customers was an agricultural engineering problem. It was first necessary to obtain information on how electric service could be used on the farms and in the rural homes, and in the operation of rural community enterprises. Laboratories were equipped, experimental rural lines were built, farm equipment was installed, and for several years agricultural engineers in Alabama—and in practically every other state—were studying and conducting experiments with electrical equipment for farming operations.

In Alabama, as in many other states, the agricultural experiment station was handicapped by lack of sufficient funds. The Alabama Power Company contributed funds for conducting the experiments; manufacturers assisted in providing equipment; and the national committee on the Relation of Electricity to Agriculture assisted in planning the program, coordinating it with other such programs, assembling, publishing, and distributing the information.

The next problem was to get the information to the rural and farm customers in such ways as to increase uses and values of electric service. For the purpose of educating farm customers in how electric service could be used profitably and satisfactorily, our company in 1926 employed its first agricultural engineer to assist farmers with their problems pertaining to their uses of electrical equipment, and to assist others in their efforts to obtain electric service.

Studies were made of the effectiveness of such work by keeping records of the rural lines on which such development work was conducted and by comparing the results with those on other lines in similar areas without development work. As the work has progressed, additional men have been employed by the company and at present there are 17 employees who devote their efforts to educational and promotional work with the company's rural and farm customers.

Educational and promotional work is conducted under the supervision of the rural and towns division of the sales department. The company's field organization is divided into six geographic divisions. In each of four of the divisions there is an agricultural engineer and an assistant agricultural engineer, and in each of the other two divisions there is an agricultural engineer. In the rural and towns division of the general office there are seven employees who supplement the activities of the divisional agricultural engineers.

The agricultural engineers are men who have had experience in farming and in rural community life. They are college graduates, some of them graduated in agriculture and the majority of them in some branch of engineering. Generally they are selected for the work through their interest in rural electrification and by their ability to assist farmers with their power problems. Their success in the work is greatly influenced by their interest in working with farmers and other rural citizens.

These agricultural engineers do not sell nor receive any commission for the sale of any equipment. They are entirely free to make recommendations to the farmer for the use of any equipment. They are expected to advise the farmer or rural customer against uneconomical uses of electric service. They are generally consulting engineers for farm customers of the company, with reference to their electric power problems. Their work is conducted through community meetings, with pictures, lectures and equipment demonstrations, and through personal contact.

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 29, 1938.

Author: Chief agricultural engineer, Alabama Power Co. Mem. A.S.A.E.

They advise the customer what installations to make, and assist him in selection of the proper size and type of equipment and with his installation and operating problems.

Average use of electric service per rural customer made its first outstanding increase in 1927, as a result of the educational and promotional work begun by the company on its rural lines in 1926, using the information from the experimental studies started in 1924. Increased use of electric service from around 400 kwh per customer to 708 kwh in 1927 was accompanied by an even greater relative increase in the value of electric service to the customers.

INCREASED VALUE OF SERVICE LEADS TO REQUESTS FOR EXTENSIONS

As a result of those increased values of electric service, requests for extensions to those lines poured into the company's offices; and for the three years of 1928, 1929, and 1930, the company built 1,500 mi of rural lines, expanding its rural line mileage by almost 400 per cent. Had it not been for the economic depression, the extensions would have continued at an even faster rate throughout the next few years, as indicated by the fact that in the early part of 1931 the company cancelled the construction of over 500 mi of rural lines in accordance with the wishes of the prospective customers.

From 1930 through 1934, the company's agricultural engineers devoted their entire efforts to working with the existing customers, to assisting them to obtain increased values from their service. As a result of that work and the development of lower priced equipment, there was, with the return of better economic conditions in 1935, a second outstanding increase in the average use of electric service per rural customer. Beginning in the early part of 1935 those enhanced values of electric service again resulted in a flood of requests for service, stimulated by news releases on the creation of the federal Rural Electrification Administration and of the Alabama Rural Electrification Authority.

Subsequently, the company built 3,600 mi of rural lines in 1936-'37, and increased its rural line mileage by 150 per cent.

During the year 1937, the average kilowatt-hour consumption per rural customer dropped from 1212 to 1041, or 14 per cent. That drop was due to four causes, as follows:

1 During the year 1,446 of the existing rural customers were transferred from the rural classification to urban rates. Those customers were on well-developed rural lines and had a high average consumption.

2 During the year 8,972 new customers were added, and their average use was low.

3 The average use on the existing lines increased only from 1,212 to 1,269 kwh, due largely to the recession in economic conditions during the latter half of the year.

4 The construction of lines progressed more rapidly than the development of increased uses and the values of electric service to the customers.

Regardless of the causes, it is a challenge to those engaged in rural electrification because it is essential that the uses and values of the service to the rural customer continue to rise if it is going to be possible to continue the expansion of the lines farther from the distribution centers, to serve fewer customers per mile of line.

The development of the increased uses of electric service by rural customers is the important and the difficult part of rural electrification. The construction of rural lines and the preliminary activities incident thereto are not difficult and are usually a very pleasant experience accomplished with the full cooperation of the prospective customers. To the citizens anxious to get electric lights in their homes, those engaged in working out the new line are heroes in the community.

But after the line is completed and the customer has his lights, and the additional expense of a monthly electric service bill, the company representative must rely on his ability to interest the customer in additional uses of electric service on the basis of cost and value to the customer. With thousands of customers widely scattered and at considerable distances from the stores and offices of the company, it is essential that the promotional work be planned and conducted to produce maximum results at minimum cost.

The company's program of load development begins before the line is built, at the time the prospective customers are trying to get lights and are enthusiastic about the electric service proposition. They are attentive and discuss the matter among themselves. It is then that information on the uses of electricity is particularly valuable.

COMPANY RESPONSE TO REQUESTED EXTENSIONS

On each proposed rural line, except on short extensions serving 10 customers or less, the Alabama Power Company holds a community meeting for the purpose of explaining the rates which will be applicable and giving detailed information on the different potential uses of electric service. The meeting is followed by the solicitation of applications for service by a company representative who calls on each possible customer along the proposed line. The rate, applied to his proposed uses of service, is explained to each customer; and those who want service sign an application card and indicate what proposed uses will be made of the service. No effort is made to urge the prospective customer to agree to install any equipment, but those uses are discussed which it appears the prospective customer is in position to use.

Upon completion of the preliminary activities, preparatory to the construction of each line and just before construction is begun, a list of the applicants is furnished the construction department, the merchandise division of the company and cooperative electric dealers in the area of the line. The list, with an accompanying map, includes the name, address, and location of each signed applicant and the equipment he expects to install. The salesman understands that the customer has not agreed to install the equipment, but that he is a prospect for it. He, therefore, does not approach the customer on the basis that the customer has promised to buy the equipment, but in an effort to sell him the appliance.

In the early days of its rural electrification program, the company learned that an attempt to hold customers to preservice promises with reference to the installation of equipment was fruitless and resulted in creating sales resistance on the rural line. The customers are going to use only what they want to, and are able to pay for. It is the company's problem to know what the customers can afford and will use electric service for, and to proceed with a program of selling them on those uses.

After a rural line is completed, the customers will buy the appliances they want and feel able to afford. Salesmen of the company and local merchants call on some of the best prospects for equipment, and make the easy sales. The other uses are to be developed by educational, promotional, and sales activities. We have learned that educational and promotional work on a rural line is unproductive usually until the line has been in operation for about a

year. The customers spend a considerable amount for house-wiring and for the appliances they are anxious for, and it requires some time for them to become adjusted to the uses of electric service.

PERSONAL CONTACTS NECESSARY TO BOOST CURRENT USE ON EXISTING LINES

After about a year, substantial increased uses can be obtained on most rural lines by a program of community meetings, demonstrations, personal contacts, and advertising. The community meeting should be entertaining and designed to get the people thinking about electric service. It is not, however, particularly valuable unless followed by personal contact work.

We have learned that demonstrations are rather expensive and usually require attendance from a considerable area to be practicable for rural customers alone. Often rural customers are invited to a demonstration of household equipment at a neighboring town and in that way the demonstration is made profitable. It is essential, also, that personal contact work follow the demonstration.

Automobile trailers with electrical equipment demonstrations are productive on rural lines at good-sized meetings and at advertised stops at crossroads and country stores, but not for more than two trips along the same line.

The personal contact work is most important and is absolutely necessary regardless of the meetings, demonstrations, and advertisements which can only speed up the contact work. The experienced agricultural engineer knows that he can't call on everybody, and that his time and efforts are more productive when he is calling on the customers who are in position to make some profitable and satisfactory use of electric service. A satisfactory installation, without any concession or discount in the purchase price, operated purely on account of its value to the customer, is, after all, the best demonstration in any community.

The normal average annual consumption per rural customer without any promotional activities is from 400 to 600 kwh. It requires considerable work to get the uses started upward from those normal uses, and it requires continuous effort and association with the rural customers to keep the increased uses of electric service in progress.

With the increasing number of rural customers and the great distances involved to contact them, it is of increasing importance that the work be conducted for maximum efficiency. Also, it is important that the agricultural engineer be provided with more information on the uses of electric service. His vision and understanding of the potential values of electric service must continue to develop, and that requires more complete information on the subject.

To date rural electrification has been developed largely on the basis of the information obtained by the agricultural experiment stations assembled and distributed through the national Committee on the Relation of Electricity to Agriculture. I think that the most constructive development of the present pertaining to rural electrification is the engineering analyses being conducted by Dr. E. A. White and J. P. Schaenzer, because they are resulting in new and useful information that leads to better rural electrification.

In 1937 the Alabama Power Company sales to rural customers amounted to 20,440,284 kwh or 22 per cent more than the total sales to all of its residential customers in 1926. The average rate per kilowatt-hour paid by the rural customers in 1937 was 4.32 cents, or only 56 per cent of the total rate paid by all residential customers of the company in 1926. That development and similar accomplishments throughout the country have not just happened. They have been brought about by constructive, energetic, and cooperative programs.

Research Viewpoints

(Continued from page 46)

"Already we begin to see possible applications, perhaps of great importance, in the fields of biophysics and bio-chemistry and at any time we may recognize applications within our own field. If our hopes are disappointed, we shall have the double consolation that our profits from the other work of Langmuir's, which I have briefly described, would suffice to cover the expense of many unproductive researches, and that, from the extension of scientific knowledge on which he has been engaged, our company, at least indirectly, will share with the rest of the public the advantages which will surely be forthcoming.

"More and more, as farm products gain in importance as materials for industry, and as the products of industry gain in usefulness on the farm, the farm and the factory will become closely allied in common interests, each helping the other to improve its products, lower its costs, enlarge its outlets, expand its profits, and realize its full potentialities for increased production of wealth and heightened living standards for all our people."—*From "Fundamental Research and Progress," by L. A. Hawkins, General Electric Co., in the "Farm Chemurgic Journal," Vol. 1, No. 3 (December 1938).*

* * *

"To meet progressively more severe operating conditions with assurance of quality and progress, the company maintains a division of engineering and research wherein is concentrated responsibility for all its engineering development and research functions. This work requires special types of engineering talent, some theoretical, some practical, and some with that rare imagination which can visualize the practical possibilities and applications of tomorrow, all combined in their relative values in the desired commercial objective.

"Our company considers the results accomplished by this work so fundamentally important that its division of engineering and research is independent of all the other divisions, reporting directly to the president. By making the division solely responsible to the directing head of the company, we believe it can attain its objectives most readily. It is assured of that freedom of action and integrity of purpose which are most conducive to fruitful scientific study. While necessarily its efforts must be coordinated with those of several other divisions, it must stand on its own feet and be free of all undue influence or prejudice. The vice-president of manufacture and the vice-president of sales act in a coordinating capacity with the president in supervising the engineering and research work. The costs of this work are treated as a manufacturing expense."—*From "Engineering Research and Company Progress," by Charles B. Nolte, president, Crane Co., in "Executives Service Bulletin," Metropolitan Life Insurance Co., Vol. 17, No. 1 (January 1939).*

* * *

The National Resources Committee has published a lengthy report entitled "Research—A National Resource," with a summary of findings and recommendations, some of which seem pertinent to progress in agricultural engineering research. These are quoted as follows:

FINDINGS

"Competition for research workers and the demand for large funds to support research have created a situation which calls for better coordination of the research facilities of the Nation than now exists. *(Continued on page 72)*

Turkey and Chicken Brooding with Soil Heating Cable

By Paul Ford

HEATING of soil for brooding is not new, for since commercial brooding of turkeys was introduced by Dr. Cline of Nevada, several other veteran turkey men have put into use many types of brooders. Some of these are heated by the so-called pit method, a length of 6-in pipe being placed in the ground directly under the brooding compartment from a pit using wood or coal for fuel. However, this method has not been satisfactory due to the fact that the heat was not controlled to any definite degree. Suffice it to say that this type was the father of the idea which I used in installing soil heating cable for turkey and chicken brooding.

In the spring of 1935 I hatched 250 poults, put them into a small soil heat brooder, and watched the results with a bit of apprehension. From my observations I could soon tell that the poults were responding to this brooding method far beyond my highest hopes. I called in several prominent turkey men and asked them their honest opinion. They were unanimous in saying that we really had something. After the first week of introduction the orders for soil heating cable ran up into thousands of feet, and soil heat brooding was considered by turkey men as a dream of an ideal brooder come true.

Construction and Operation of the Brooders. An ordinary width of tar paper is placed on the ground or concrete, and covered with an inch of coarse sand. On this the cable is laid with 3 or 4-in spacing. About 2 in of coarse sand is placed over the cable. A thermostat bulb is located directly between the cables, just underneath the surface of the sand, so as to get the temperature as near the reading on the indicator of the thermostat as possible, this being from 100 to 105 F (degrees Fahrenheit) for the first week and gradually reduced. This bulb must be placed in a separate compartment to prevent poults from sitting on it and cutting off the power. This is a special soil heat thermostat which has been used in most installations. However, we are now working on the use of a wafer-type thermostat, as it seems to give a more accurate adjustment.

Burlap is laid over the sand to prevent the poults from scratching down to the cables. The cables being spaced 3 or 4 in apart, using 8 cables in width gives approximately 32 in in width of heated area, with the length depending on the number of units desired. The cable is cut in lengths of 120 ft for 220 volts, or 60 ft for 110 volts, with each thermostat carrying 25 Amperes.

Brooding compartments are then placed over the heated areas. These compartments are constructed out of 1x12 material set on edge. Each measures 3x6 ft and is usually built into sections of four. We confine 80 to 100 poults in each compartment for two or three weeks, depending on the weather.

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Agricultural field representative, Pacific Gas and Electric Co.

Usually the heated section only is covered and a burlap curtain dropped to within an inch or so of the floor, between it and the unheated section. The covering can be boards, canvas, or tar paper.

We also place a 60-watt bulb in each compartment for light and as a source of overhead heat.

This type of brooder has advantages in the ease of moving it about from place to place, as is the custom of many turkey men, and in being adaptable to any type of house or open-shed brooding. It provides a reserve heat built up in the soil, which will last from 3 to 8 hr, depending on the weather. The source of heat is controlled thermostatically and gives off no odors, and there is no danger of fire at any time. The brooding compartment is kept dry, which tends to keep down disease. We have had no serious outbreaks of any disease in this type of brooder.

Turkey men, where brooding costs were kept, report that one cent per bird covered their brooding costs.

This type of brooder requires attention, the same as other types. However, in my opinion, based on observation throughout my territory, it comes nearer to being foolproof than any other brooder yet designed.

Paint to Meet Farm Service Conditions

(Continued from page 50)

that spends its winters in a snow drift along the fence line I will not venture to guess.

Except for inside painting done for color only, one-coat painting is never economical. One coat of paint cannot be applied uniformly enough to avoid thin spots which are points of weakness in the film and which cause early failure. Irregularities in the surface painted, brush marks, missed spots, dirt and dust particles imbedded in the film all contribute to the formation of breaks and pinholes. A second coat more than doubles the chance of uniformity.

There are different kinds of aluminum paints formulated for different purposes. In general, an aluminum paint marketed for general use under outside exposure will give good results on any surface. However, there are aluminum paints formulated especially for use on steel, or on wood, or on furnaces, and so on. When used as intended they do a good job. When used otherwise they may turn out just as badly as would a nile green interior flat wall paint used on a gasoline storage tank out of doors. That is only reasonable. Furthermore, there are aluminum paints of various qualities and prices just as there are house paints sold from a dollar up. The appearance of an aluminum paint or the film it produces is no indication of what is in it or of what it will do as far as durability is concerned. It is unfortunate, but nevertheless true, that aluminum paints are more subject to shenanigans and fenagling than are many other paint materials.

The best insurance in buying it, therefore, as is the case with any other paint, is to buy good quality material recommended for and suited to the work to be done, from a manufacturer or dealer of good repute and in whom you have confidence.

Water Application Efficiencies

By O. W. Israelsen

THE TERM "water application efficiency" as used in this paper is defined as the ratio of the volume of water stored in the soil in one irrigation to the volume delivered to the field. It is commonly expressed as a percentage. Beckett and coworkers in California have defined "efficiency in irrigation" as the "percentage of the water applied that is shown in soil-moisture increase in the soil mass occupied by the principal rooting system of the crop." Water application efficiency, as used herein, has the same meaning as the expression "efficiency in irrigation" used by California irrigation research workers.

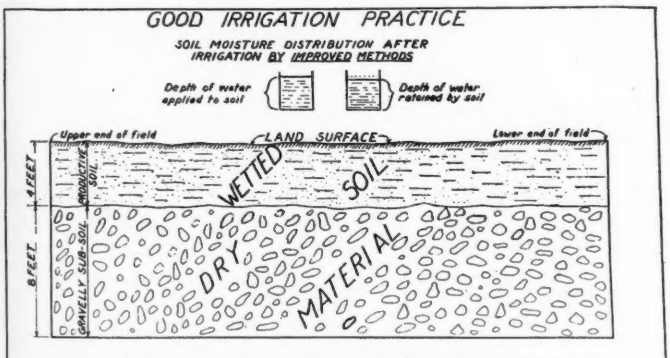
As defined above, the water application efficiency is clearly a dimensionless physical quantity which is not a direct function of crop responses to irrigation. It is a measure of the degree of soil moisture storage attained under a particular method of application. High efficiencies will probably necessitate the adoption of improved methods of irrigation at higher costs than are necessary for methods which result in low water application efficiencies. The attainment of satisfactory water application efficiencies concerns every irrigation farmer each time he irrigates, and he may properly look to the agricultural engineer for desired assistance.

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

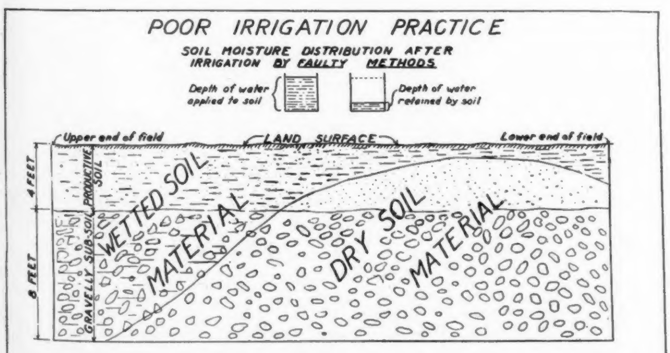
Author: Research professor of irrigation and drainage, Utah Agricultural Experiment Station. Fellow A.S.A.E.

Influencing Factors. Water application efficiencies are influenced by some factors which the irrigator cannot control. He cannot, for example, control or change materially the texture or the depth of his soil, or the variability in these soil properties from place to place on his farm. He can change, to some extent, the permeability of his soil to water, but only within rather narrow limits.

On the other hand, the irrigator has within his power rather complete control of methods of preparation of his land for irrigation and of methods of water application, including the time-rate of application; and by intelligent control of these factors he can influence water application efficiencies to his advantage. In the irrigation of shallow soils of high permeability, particularly by the flooding methods, low efficiencies result frequently from low time-rates of application and excessive deep percolation losses in the soil at the upper end of the irrigation plot. These losses of water by deep percolation during the time of application with resulting low efficiencies occur "in the dark." Because of the fact the irrigator cannot see them, he frequently underestimates their magnitude and significance. Reduction of deep percolation losses is a goal toward which some irrigation farmers need to strive continuously. By appropriate adjustment of the size of stream to the length and width of irrigation plot, and to its soil permeability and slope, it is possible to moisten the soil to the desired depths without sustaining excessive deep percolation losses. The accompanying diagrams illustrate the resulting conditions for both proper and improper application methods.



IMPROVED IRRIGATION METHODS INSURE HIGH IRRIGATION EFFICIENCIES



FAULTY IRRIGATION METHODS INSURE LOW IRRIGATION EFFICIENCIES

Measuring Water Application Efficiencies. It is important that methods for measuring water application efficiencies be developed that are applicable throughout the irrigated regions. Otherwise results obtained will have only local significance. Measuring of water application efficiencies consists of three important phases or steps, as follows:

1 Provide an appropriate water measurement structure for the farm—a weir, an orifice, a Parshall flume, a Calco meter gate, or any other inexpensive, reliable structure.

2 Provide for a reasonably constant flow during the period of delivery to the field.

3 Provide for measurement of the amount of water that is stored in the root zone of the soil at each irrigation.

Satisfactory progress has been made during recent years toward the achievement of the first two steps. Therefore, without minimizing their importance in the measurement of water application efficiencies, they will not be considered further herein.

The third step, that of measuring the volume of water stored in the soil at each irrigation, is more perplexing, and there will be difference in opinion concerning the proper procedure. Since direct measurements of soil moisture content by

volume are impractical, it will be necessary to obtain them by conversion from the direct measurements for soil moisture content by weight. Representative measurements of the apparent specific gravity of the soil are necessary to make this conversion from per cent by weight to per cent by volume. Moreover, two assumptions must be introduced, namely, (1) the depth of soil in which the soil moisture may be considered as "stored" and available to crops, and (2) the time period after irrigation at which further downward flow of water may be considered negligible, and therefore at which all of the moisture "stored" in the soil of the root zone will be available to crops.

In view of the facts that soil moisture determinations at best must be restricted to the soil from a few borings per acre, and that at least two assumptions must be introduced, it is evident that a high degree of accuracy in the measurement of water application efficiencies should not be expected.

The following illustrative example may help to clarify procedure in the measurement of water application efficiencies:

To irrigate a 10-acre crop of alfalfa a farmer uses a 3-sec ft stream for a period of 30 hr, thus applying 90 acre-inches, which if spread uniformly is equivalent to a depth of 9 in over the field. The soil is a loam underlain by sand and gravel at depths of 6 ft or more. Apparent specific gravity tests show a mean value of 1.3 for the upper 5 ft of soil.

It is assumed that (1) the effective depth of soils forming the root zone for the alfalfa is 5 ft, and (2) the flow of water downward into the soil below a depth of 5 ft is negligible 24 hr after irrigation has been completed.

The increase in soil moisture content by weight, obtained by sampling and drying the soil before irrigation and again 24 hr after, is shown in column 2 of Table 1 for each foot depth of soil down to 5 ft. By introducing the apparent specific gravity factor of 1.3, these moisture percentages have been converted to equivalent depths in inches of water, and are shown in column 3. As seen from this column, the total depth of water stored in the upper 5 ft of soil, 24 hours after irrigation, is 4.02 in. Since a total of 9 in was applied, the water application efficiency is 45 per cent.

Measurements. In 1919, Smith stressed the importance of the concept of efficiency in irrigation to Arizona farmers, and called attention to practical ways by which efficiencies could be increased. He said that "the efficiency in irrigation can be defined as the ratio of that portion of the water actually utilized by the crop to the total quantity applied to the land."[1]

It is somewhat more difficult to measure the efficiency in irrigation as defined by Smith than it is to measure the "water application efficiency" as defined herein. Some water application efficiency measurements are briefly mentioned.

California Studies. During 1926 and 1927 Beckett, Blaney, and Taylor measured the "efficiency in irrigation" (herein designated "water application efficiency") on farms in California irrigated by the furrow method and also by the spray method.[2] Soil samples were taken to a depth of 6 ft and a wide range in efficiencies was found. For the 40 observations made during the two years an average water application efficiency of 52 per cent was obtained, with a maximum of 73 per cent and a minimum of 26 per cent. The following comments concerning the efficiency studies were made by the authors:

"Under conditions characterized by rolling topography and where the furrow method of irrigation was used, low efficiencies generally resulted from excessive runoff from the ends of the furrow. . . . . .

"As a result of the measurements and observations made during the years, the conclusion is drawn that under existing conditions as found in the areas under observation, the average efficiency which may be expected under good irrigation practice is about 60 per cent."

Utah Studies. In cooperation with the U. S. Bureau of Agricultural Engineering, the Utah Agricultural Experiment Station is conducting water application efficiency studies on a number of farms in Utah County, Utah. Considerable soil moisture data were collected during 1937, but not all of the factors needed for computing efficiencies were measured, and therefore the preliminary results are based in part on assumed values of apparent specific gravities. It appears from the 1937 studies that water application efficiencies on the bench-land farms of Utah County will be lower than those in California.

Utility. The utility of the concept "water application efficiency" is not yet widely recognized. It is probably thus far recognized only by irrigation research workers. The concept of efficiencies in irrigation has been considered by irrigation students in most of the western states, and particularly in Arizona, California, Oregon, and Utah. The California Agricultural Experiment Station made the first detailed field measurements known to the author.

The concept of water application efficiencies is of particular value in helping to clarify to irrigation farmers the importance and the limitations of storage of irrigation water in the form of capillary soil moisture. This is especially true for irrigators having highly permeable, shallow soils from which they lose large amounts of water through deep percolation, and its importance demands emphasis. Farmers cannot attain high water application efficiencies without satisfactory methods of application.

It seems that *measurements* of water application efficiencies merit more attention than they have been given thus far. Perhaps these measurements should be made largely by public irrigation research agencies. Irrigators cannot under ordinary practice afford to measure their water application efficiencies at each irrigation—the costs are probably prohibitive. On the other hand, many irrigators can profit by *measuring* the volumes of water they apply in each irrigation and *estimating* the root zone soil depths, the volumes of water stored as soil moisture, and the resulting water application efficiencies. It is probable that such estimates, wisely used, may have considerable practical value.

ACKNOWLEDGMENT. The author acknowledges with gratitude assistance on this paper given by Mr. Russell R. Poynor.

TABLE 1. TYPICAL MOISTURE PERCENTAGE INCREASES FROM ONE IRRIGATION, TOGETHER WITH EQUIVALENT COMPUTED DEPTHS OF WATER IN INCHES, USING AN AVERAGE APPARENT SPECIFIC GRAVITY OF 1.3

	Moisture increase	
Depth of soil, in	Dry weight basis, per cent	Equivalent depth of water, in
0-12	7.8	1.22
13-24	6.6	1.03
25-36	4.2	0.65
37-48	3.8	0.59
49-60	3.4	0.53
0-60		4.02

[1]Smith, G. E. P. Use and waste of irrigation water. Ariz. Agr. Exp. Sta. Bul. No. 88, p. 222, 1919.

[2]Beckett, S. H., Blaney, Harry S., and Taylor, Colin A. Irrigation water requirement studies of citrus and avocado trees in San Diego County, California, 1926-27, Calif. Agr. Exp. Sta. Bul. 489 (1930).

Experience in the Utilization of Farm Machinery for Greater Efficiency

By B. Gwynne Burr

IT IS assumed that experience in the utilization of farm machinery for greater efficiency includes successful attempts to achieve efficiency, as well as those which were unsuccessful. It is also assumed that efficiency refers as much to the relation of equipment to cropping program as it does to the day-by-day use of the machines in the field.

The operations to be discussed were started in 1931 on a 900-acre unit of the Upper Gwynne Farms located in Madison County, 25 miles west of Columbus, Ohio. The original plan was set up on a straight grain basis with two fields, one of 400 and the other of 500 acres, and two crops, corn and oats, with sweet clover seeded in the oats. The idea was to plow the sweet clover under in the fall and to disk the stalks for the oats in the spring. By this method, only one crop operation was going on at a time and all the equipment was concentrated in one spot for that operation. Two tractors were used, a 30-hp track-type tractor and a four-wheel-drive general-purpose machine. Plowing was done with a four-bottom, 16-in plow, disking with a three-section, 8-ft disk hitch, seeding with three 10-ft drills, mulching with three 9-ft cultipackers, and harrowing with 40 ft of spike-tooth harrow. All of these were pulled by the 30-hp tractor. For planting corn, four two-row horse drills were ganged together back of the general-purpose tractor, which did the cultivating with a four-row trailer corn plow of a special type. For harvesting oats, a 16-ft combine was used, and for picking corn, a two-row, pull-type picker. Both of these were pulled by the "30".

As can be seen, the simplicity of this set-up was too good to be true. Adverse weather conditions at times greatly overtaxed the capacity of the machinery, with the result that sometimes the crop operations would not be completed. In 1933 the oats seeding was less than 50 per cent completed. The 500 acres of corn cultivation were too much for one tractor to handle and the same was true of the combining, as, in Ohio, one cannot count on more than an average of twelve 8-hr harvesting days in July. The 500 acres of corn picking was too much to handle in some years, as experience shows that 350 to 400 acres is a good average season's run for a two-row machine. Added to the overloading of the machinery was the fact that oats apparently cannot be grown at a profit in central Ohio, as our average yield has been between 10 and 20 bu and the price about 25 cents. All of these considerations forced a gradual swing to a greater diversification of crops and to more careful treatment of the culture of each one.

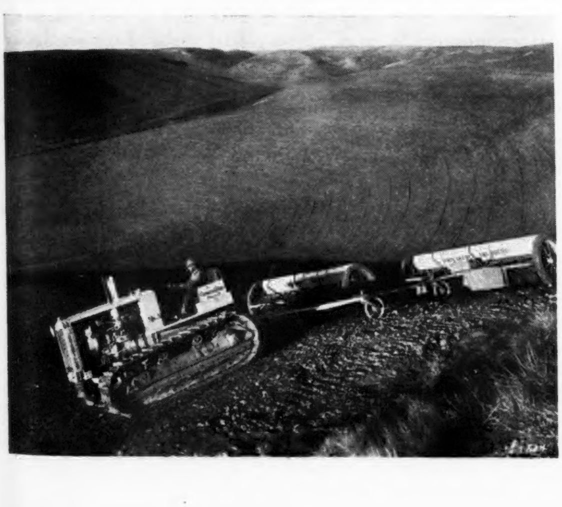
In 1935 the crop operations on the farming unit had been reduced to 780 acres, with three crops, namely, oats, soybeans, and corn, using the same equipment. For 1936, oats were given up in favor of wheat, and since then the farm has been growing about 200 acres each of wheat, soybeans and corn, with one speculative flyer in winter barley following the short corn crop of 1936. Each year for the past five we have had 100 to 150 acres of summer fallow for Canada thistle control. This year the entire unit is finished once over and from now on it is planned to do clean-up work on their eradication by patching in the soybean fields, that is, seeding a field to beans, letting the thistles come up, then ripping up the patches and keeping them bare until a killing frost in the fall. This clean-up work is made necessary because even though an entire field is kept bare for a season and most of the patches are killed, some of them always reappear and require further work for their complete eradication. Next spring, with the release of the land that was formerly fallowed, 100 acres of alfalfa are to be seeded for a dehydrating plant located in the vicinity.

As can be seen, the tendency for the past 5 yr has been toward greater diversification, and yet the smallest field on this farm contains 100 acres. This breaking down into smaller units has certainly reduced the efficiency to some extent, but it has made farming operations much less risky in that they are no longer dependent on two crops and one season, and more attention can be given to each crop.

At the time the cropping methods were changed, the two gasoline tractors had each had about four years of service at 1500 hr per year and we began to look around for some more economical power units, as the bill for fuel and oil was averaging around $1600 per year, including what was used in the truck and combine. The first move was to replace the four-wheel-drive tractor with a small distillate-burning track-type machine; a distillate, rubber-tired, tricycle type of tractor was added for corn planting, cultivating, and general work; and the "30" was replaced with a corresponding diesel. That year we operated each of these three machines 1500 hr, plus two combines and a truck for $1700 worth of fuel and oil. Since that time, another 30-hp diesel track-type tractor and one of the new small diesels have been added to take care of the increase in the custom work done on neighboring farms, and enough tillage and harvesting machinery was added to keep them busy.

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 29, 1938.

Author: Operator-manager, Upper Gwynne Farms. Mem. A.S.A.E.



Our experience with the low-grade fuel engines has been very successful, once we have found the best available fuel and spark-plug combination. We suspect at times that the characteristics of the fuel from a single supplier vary over fairly wide ranges and the condition of the spark plugs on occasion shows a heavy sulphur deposit which finally shorts them. For this reason we will welcome any standard specification that may be introduced.

As regards the diesels, I am not going to ballyhoo their low operating cost, but to discuss some of the operating problems we have encountered. The first was fuel supply. At the time we bought our first diesel none of the specially prepared fuels was available in central Ohio and we had to start out with a No. 3 furnace oil. This fuel seemed to have satisfactory ignition qualities once it got going, but it was hard to start and had a large amount of dirt that was stopped by a 0.001 filter; what went on through we don't know. The amount of dirt was so alarming that we changed as soon as we could to a special dieseline which had much less dirt and better starting qualities, and so far we have not replaced a single fuel pump unit.

In regard to injector trouble, we have not been so fortunate. During certain operations such as pickup-baling and combining, a tractor engine with a maximum governed speed of 1400 rpm may run all day at 400 or 600 rpm, and during such times a hard carbon cone forms around and in the injector orifice. At first, the maker of our tractors considered his injectors as something akin to Pandora's box and not to be monkeyed with, but after buying about six of them at $10 each, we started cleaning them ourselves and have not bought one since. This type of injector trouble seems to be chronic with most diesels, and while fuel characteristics may have something to do with it, they are probably not the whole story. We have had one occasion so far when a diesel sucked the oil out of its air cleaner and started to run away. Luckily the operator kept his head and did not release the clutch, which would have been disastrous; instead he kept the engine under load and released the compression thus stopping it before any damage was done. When one thinks that air cleaner clogging can occur very quickly in spite of daily cleaning, especially during the combining season, it seems foolish that diesels are not equipped with a tight-fitting butterfly in the intake manifold, automatic or manual, to shut off the air supply in case of runaway, especially as all such engines do not have a compression release.

TRACTOR MAINTENANCE SYSTEMATIZED

For the maintenance of our tractors we have a fairly strict routine. Each machine has a time clock or an hour meter, and certain operations listed in a record book kept on the tractor must be carried out every 50 hr; these and additional ones at every 100 hr, and still others at every 300 hr. Our tractor repair bill per year is low per dollar invested, as compared with the other tools we operate. We estimate it to be about 5 per cent of the cost of the machine per year. In 1938 our repair cost for all equipment, including parts and labor, was $2,615 for a machinery value of $21,782, or 12 per cent. Our feeling is that these figures show that the tractor is today about the only farm tool designed to stand up properly under severe service. It is certainly the only tool that we can overhaul carefully once a year and be reasonably sure that it will go on to the next overhauling without some serious breakdown, as our time-clock records show a negligible amount of lost time chargeable to tractor failure. This does not take into consideration the time spent in locating the "bugs" in the first few months production of a new machine, troubles that somehow never show up in the pilot models but which do seem to show up rapidly in field operation. We have had several cases of this in tractors and other machines, and may I say now that it is my feeling and that of other large machinery users in our vicinity that this class of trouble could be reported and corrected much more quickly if the users were not forced into the position of having their only contact with the designer through the sales department. One company whose tools we use has a service department and we have found it much easier to deal with and to get our ideas across to them than in those cases where we have to take our trouble to the man who sold us the machine and who hopes to sell more. Generally our comments and criticisms go no farther than his office because he has been told at a sales meeting that the machine is pretty close to perfection and he insists on believing it, at least until a superseding model is produced, after which he will admit anything in the hope of selling a new one.

BREAKDOWN OF MACHINES DURING HARVEST

The problem of the breakdown of machines during harvest is the most serious one that we have to face, because it is then that pressure is on us to do the job promptly, and of the tools that we use the most complicated and unreliable are the combine and the corn picker. By unreliable I mean that these machines fail in such unexpected and unreasonable ways that we have as yet found no way to protect ourselves adequately against them. To the discredit of their designers and builders these two tools give more trouble in their early use, say, the first season or two, than they do later on. This is primarily because whenever a weakness develops that we can correct we do so, strengthening the parts and guarding against future failure. A case in point is our experience with corn pickers of which we have three of the same make, two pull type and one mounted. One pull picker was purchased in 1931 and was operated each year, except one through 1935, averaging about 12 per cent lost time for repairs. In 1936 it was completely rebuilt and strengthened, and its lost time for repairs dropped to about 3 per cent for 1936, 1937 and 1938. In 1936 we purchased a mounted picker which lost 16 per cent for repairs the first year, 7 per cent the second, and went through the last one after a major rebuilding with 6 per cent. This fall we purchased a second pull-type machine of the same make as the first but quite different in design and supposed to be much better. It distinguished itself with a record of 15.5 per cent repair time. In fairness, I must say that we were warned of some of the troubles we could expect, but by no means all of them, and this machine was supposed to have had a year's testing before production was begun. In tabular form it looks like this:

Time lost for repairs	1931-1935 per cent	1936 per cent	1937 per cent	1938 per cent
Pull picker No. 1	Abt. 12	3	3	4
Mounted picker	—	16	7	6
Pull picker No. 2	—	—	—	15.5

In other words, after building pickers for ten years, this particular manufacturer does not seem to be able to build a more reliable one today than he did in the beginning.

If one breaks down the 1932 performance tests of pickers at the Iowa station, it is found that "stops during test" consumed 10.5 per cent of the total elapsed time for seven tests of 3.44 acres each. The cause of these stops was not given, but they were not for changing wagons, for turns at ends, or for servicing. This seems to be an ex-

tremely high percentage of lost time for such short tests and it convinces me that our experience is not unique.

In regard to combines, of which we have three, two 16-ft and one 12-ft, our experience has been about the same as with the pickers, except that the percentage of time lost is, in general, less than in the case of pickers. Here, however, breakdowns, if severe, are apt to be more important than in the case of the picker because of those twelve 8-hr harvest days that I spoke of before. One can make an interesting comparison, whether significant or not, in considering that in our own case the cost new of a 16-ft combine is approximately one-fifth the average value of the crops harvested per year, whereas a picker is worth only one-fourteenth of the average value of a year's harvest. On this basis it would appear that a picker could be built to cost about twice what it does now, and, if properly built, it would still be a profitable machine to operate since its per-hour capacity would go up and its repair cost would come down to compensate for the increase in overhead. I understand that there has been for some time a movement toward precision-built farm machines on the Pacific Coast, and it seems time that they found a place in the corn belt.

DAILY SERVICING OF MACHINES

Another problem that we have at all times is the matter of servicing machines for a day's run. Our records show that, on the average, this will amount to about 10 to 15 per cent of the time the equipment should actually be operating and observations indicate that most of this time is spent in lubricating. Here we feel that much progress could be made by a swing away from the high-pressure, small-volume automotive type of lubricating gun and fitting to a low-pressure, large-volume type. The clearances in most agricultural bearings can be measured with a ruler instead of a micrometer caliper, and it is ridiculous to use a lubricating system of the type now supplied. After eight years of experimenting we are using in our work a medium-fiber grease with a great clinging power of the type developed some years ago for use in tractor track rollers. It has proven very satisfactory on our own and neighboring farms and much more suitable than the buttery, standard pressure-gun grease that is generally used. Wherever we could, we have changed hydraulic fittings to low-pressure button heads with a great saving in service time. Unfortunately this can only be done where clearances are sufficient for the button-head coupling. What we would like to see is a series of small button-head fittings for ⅛-in pipe thread with a lever-type gun developing about 2500 lb pressure. With the push gun it is often difficult to get into a position to give a straight push on the gun, and a push at an angle will often snap the nose off the fitting or, if it is a long one, break the fitting off altogether. The popularity of the lever type gun is increasing rapidly as cheaper models are being offered in combination bargains with a bucket of grease in most implement stores, but so far no one seems to have thought of putting them out as standard equipment on a tractor or an implement.

In order to facilitate moving, to lighten draft, and to ease shocks on equipment, we have gone in heavily for rubber tires on many implements. Due to the fact that we do twice as much power work on other farms as we do on our own, long moves are sometimes called for. Due to state highway department width restrictions, it is not always possible to load some tools on a truck, and for short moves it would not save time to load even those that could legally be carried. Our use of tires on implements will undoubtedly increase as older units are replaced with new ones.

As to pneumatics on tractors we are still pretty much on the fence. We have one tractor so equipped, and, while the tires undoubtedly save fuel and wear and tear, there are many times when the tractor cannot be operated without chains, which are a nuisance and wear out rapidly. During sloppy weather, when picking corn, we use chains on the front wheels to keep them from clogging with mud and trash. The best solution to date for the one-tractor farmer seems to be to have both rubber tires and skeleton wheels, as the added cost of the skeleton wheels is little more than twice the cost of a set of chains and they will outlast chains many times. One thing we have learned from actual test last June on the jackwax Brookston soils, which do not dry out uniformly in the spring, is that rubber tires will pack the soil much more than skeleton wheels or tracks, to such an extent in fact that planter runners and drill disks will not penetrate in the wheel marks. I have often wondered why some tractor designer hasn't gone back 20 years or so and rediscovered the old crown-and-worm differential that always delivers full power to both wheels as long as the one trying to slip has at least 10 per cent traction. A modification of this drive has been used in a four-wheel-drive truck made in the East for over ten years, with apparently satisfactory results. Such a drive in a tractor would remove one big objection to the use of rubber by doing away with the necessity for chains in many instances. A four-wheel-drive tractor on rubber with this positive differential in each axle would seem to have possibilities, but, since this type of machine steers like a blind

horse when going forward and backs like an intoxicated crab, it might have its disadvantages from an operator's standpoint.

PLOWING IN SOIL WITH A DRAFT OF 1000 LB PER FOOT

For plowing we are using three-bottom and four-bottom plows, and, after seeing some of the draft figures in the Iowa bulletin, I often wish that our farm were west of the Indiana-Illinois line. The average draft of a plow per foot width given in the Iowa bulletin is about 550 lb. For the past two years we have been working with an average draft of 1000 lb per ft at 6½ in depth and 2.5 mph, and, in one case of alfalfa sod plowing last spring, it went to 1520 lb per ft at 1.75 mph. This naturally makes plowing costs relatively high, especially if trash conditions materially cut down the time moving forward. We plow under all crop residues, no matter how much trouble they cause, and the clogging problem is the biggest one we have to face in this operation. High-clearance plows with the axles on top of the beams are *not* the complete answer, although they help; but the chief difficulty is in the failure of the rolling coulters to cut properly in the damp trash. Our experience with the U.S.D.A. self-aligning, concave disk-type coulter which we have used on one plow for a year indicates that it does a better job than anything we have tried. The shank is subject to breaking too often when used on heavy plows, but the development of a spring release or spring trip shank would cure this trouble. Due to the partial jointer action of the concave disk this coulter throws trash well down into the furrow and leaves the ground in good order for subsequent fitting operations.

For general seedbed preparation we alternate between the tandem disk harrow and the field cultivator with spring teeth. When speed and trash conditions do not govern, we tend to favor the field cultivator because of its greater working depth and better weed control in thistle-infested fields. The stiff-tooth cultivator will work to a somewhat greater depth than the spring-tooth, but it does not have its shovels as closely spaced, and, paradoxically, it tends to clog more with trash. The general set-up of our seedbed preparation tools and drills is such that we can pull one unit back of the general-purpose tractor, two units back of the small tracklayers, and three units back of the large tracklayers. This is done by means of multiple implement hitches, and provides a flexibility of equipment so that implements can be fitted to the size of the field being worked, or to the size of the tractor available for a job if the others are busy somewhere else. The use of these hitches means that we have to use hand-controlled instead of tractor-controlled disk harrows because of the difficulty in backing to straighten out the gangs. We can see no objection to this as harrows once set seldom have to be changed. As regards tractor-controlled disks, it would seem reasonable to build them so that they straighten by moving forward instead of backward, then when they bog down, as they sometimes do, a lot of messy backing to straighten them would be avoided, and for ordinary going there would be no more backing with this type than any other.

CHECKROWING CORN

When planting corn we now use the same type of four-row check planter used at Ames with the fertilizer attachment. In our neighborhood the 40x40-in spacing seems to be the most popular. For some reason, the machine pictured in use at Ames was converted from a straight-wire type to crossover wire, and while our experience with this planter as originally equipped was reasonably satisfactory as to accuracy of check, we improved its performance by using the drum payout type of anchor stake. It seems a shame that methods bordering on the criminal have to be employed by an owner of a green and yellow planter to obtain attachments for a red and yellow one, but at any rate we have them and like them. On the farm north of ours they are operating three four-row crossover machines, each with its own tractor, simultaneously on a single wire more than a mile long and I leave it to your imagination to figure out what happens to their check when all three check heads hunt into step and out again as the tractor governors vary.

Speaking of long wires, we hold to the theory that for a single planter, after a certain critical length of wire is reached and passed, say, 80 rods and up, wire travel between trips remains constant, as the ground resistance of the wire becomes equal to or greater than the load of the checking mechanism. Our experience with wires ranging from 40 to 250 rods bears this out. Last spring we tried the use of a cultivator on the tractor while planting, cultivating a strip about 12 in wide ahead of each planter shoe. It was found to be useful in breaking a crust caused by a heavy rain on a previously prepared seedbed, but due to the heaviness of our soil we do not see many possibilities in this as a substitute for a final fitting operation. The corn is cultivated with the four-row cultivator which has floating knee-action rigs equipped with sweeps or shovels as conditions require. Each rig has its own gage wheel which is an almost essential condition to the use of a four-row tool.

OPERATING COST FIGURES

In spite of our soil type, which requires much more time for plowing and seedbed preparation than the lighter central western soils, the use of the larger mechanical units had kept our operations at an efficiency about equal to that of those recorded in the Iowa bulletin as shown by the following comparison for corn production:

	Man-hours/Acre		Tractor-hours/Acre	
	Iowa '33	U.G.F. '36	Iowa '33	U.G.F. '36
Seedbed, plant, cultivate	4.22	3.92	3.6	3.6
Harvest	2.5	3.48	1.3	1.4
Total	6.7	7.4	4.9	5.0

The Iowa figures are for 18 acres and ours are for 200 acres, and I feel that our figures are truly representative, as we were not trying to establish any speed records but were merely farming along our usual way.

For wheat and beans the following figures show where large machinery units really come into their own:

	Man-hours/Acre	Tractor-hours/Acre
Beans 1936 — 170 acres	4.0	2.0
Wheat 1938 — 100 acres	3.3	1.4

I suppose that that part of our activities which attracts the most attention is the custom work that we do for our neighbors. Starting from a few combining jobs done as a favor as much as anything, it has grown to be the biggest part of our business, so that the tail now wags the dog. This work is no different from the work we do at home, but it has created several problems of its own. One of these is that we have a small pickup truck for each outfit we put in the field to carry the men to and from their work. Another is the increasing importance of good equipment, as customers are not often as tolerant of delays as we might be ourselves. Another is the matter of fuel and oil supply. We are using a small tank truck which visits each tractor once or more a day. The use of this truck means that all the diesel fuel is carried in one tight container instead of in cans where *(Continued on page 63)*

The Method and Effect of Deep Tillage

By G. Douglas Jones

MAN MUST eat to live, although some live to eat. Few of us realize that the intake of the normal human stomach is practically a ton of food per individual per year.

Exact science cannot yet definitely state the true function of the so-called "big three" in food, namely, carbohydrates, fats, and proteins. Scientists can tell you that the chief function of the carbohydrates, namely, starches and sugars, is to produce energy; that fats, especially animal fats, are extremely important and necessary in the life of man, forming a protective layer around the nerves, and are also essential for brain activity, in fact, for the entire nervous system, yet one cannot find definite agreement as to the exact function of fats. The proteins are responsible for the vital part of the living cell in which we find protoplasm. While it is yet impossible to single out any one absolutely necessary substance as the most important in the system, yet as Pauli has stated, "the proteins more than any other group of substances, display those properties which combined we call life."

Endless discussion could be carried on relative to these essentials of life, and entering into this discussion, we would find that the vitamins play an important role, and little or nothing would be heard of those fundamentals of all agriculture, the essential minerals, except possibly calcium, phosphorus, potassium, and iron.

But what of the other minerals found in the human body? What of their function? Do we require the presence of these minerals in our system? Qualitative chemical analyses of the human body have shown that it contains oxygen, carbon, hydrogen, nitrogen, calcium, phosphorus, potassium, sulphur, sodium, chlorine, magnesium, iron, manganese, iodine, copper, fluorine, aluminum, arsenic, boron, bromine, lead, rubidium, tin, titanium, and perhaps a few other elements.

Presented before the North Atlantic Section of the American Society of Agricultural Engineers, at Boston, Mass., September 20, 1938.

Author: Agricultural engineer, Cleveland Tractor Co. Fellow A.S.A.E.

Whether we live on animal or vegetable food, the minerals which become part of our bodies must come from the soil. What will happen to the human being when the soil becomes depleted of vital mineral elements?

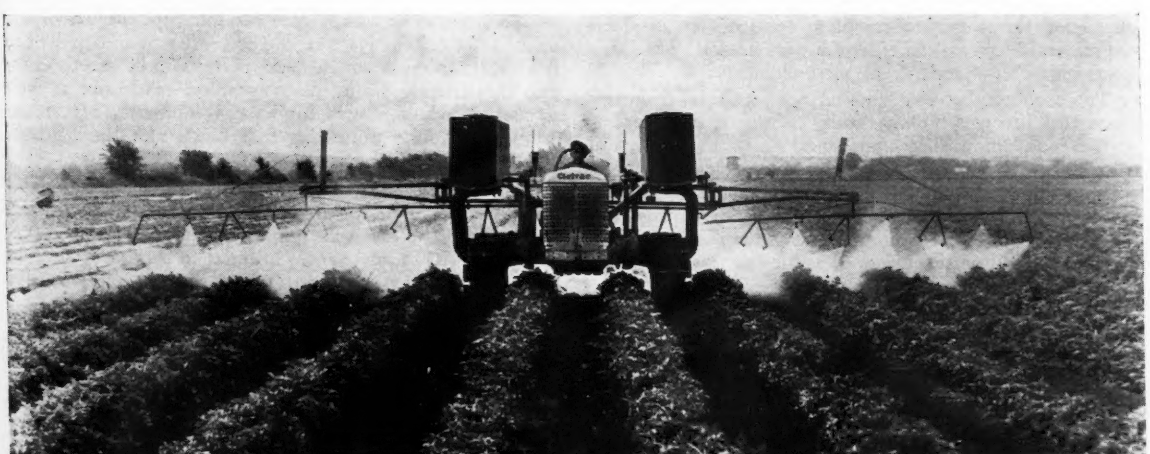
There is no cause for alarm that one morning our farmer brethren will awake to find that the essential minerals, those elements which produce plants that we in turn may eat and live, have vanished. But as we remove the growth from the soil, and ship it away to other parts of the country and abroad, we are removing these elements, and when no attempt at replacement is made, slowly and surely our soil is being depleted and the results of this depletion are reflected directly in plant growth and yield, and, in turn, upon the health of man.

When we remove from the field 50 bu of corn, and this does not include the stover and cobs, we take out of the soil approximately 50 lb of nitrogen, 16 lb of phosphoric acid, 12 lb of potash, about 28 lb of lime, and the rarer minerals that are contained in corn. It is true that the amount of the salts and minerals in crops is small, but so is the total amount contained in the soil, in some cases only a trace. When that trace has disappeared, trouble begins.

The soil depth of any farm is practically unlimited, as far as farming operations are concerned, and this includes the sinking of wells for water supply. But when we analyze farms in terms of depth measurement, we find a measurement not of feet but of inches. The average depth of the American farm does not exceed eight inches, the larger portion of the farms having a depth of only five to six inches, and every farmer using the general run of farm equipment is hard at work making sure that his farm will not exceed the five, six, or eight inches that he has set up for his operations. He calls it a seedbed. How correct this terminology is—just a seedbed, no thought being given to the rootbed.

I have tried to analyze this condition and see why it is so prevalent in our agriculture, and in doing so turned back to Biblical history.

In the olden days man's mentality was such that before



he could understand or even attempt to comprehend a thing, it was necessary to have a visible symbol, which accounted for so many idols of worship. An unseen God didn't amount to much, but a visible material deity, one that they could touch and point to, was the God they worshiped and fought for. It appears that is also true of our agriculture. The things that are seen are given first importance, and the things that are not seen do not seem to matter much. We spray leaves, stems, and branches because they are visible, but how many know what is going on in the soil surrounding the root, where the majority of the surface insects originate or hibernate. When we have provided our seedbed, giving special attention to the surface appearance, we think our work is well done. Then the seed is planted, the crop possibly given a few surface cultivations—and then we sit back and crab all winter about the poor crops we harvested last fall. Possibly I should mention the addition of a small amount of manure or commercial fertilizer—this fertilizer generally applied in quantities computed by pure guesswork, the analysis made up and shipped by a fertilizer manufacturer one hundred miles or more away, and the container bearing the percentage signs of that great fertilizer trinity—nitrates, phosphates and potash.

No thought is given to the crops that have been raised, whether it was spinach, potatoes, or lettuce that removed quantities of iron; whether it was vegetables, grain, or peas that removed copper (if any); or whether it was a crop that took iodine.

CROP USE REQUIREMENTS AS A GUIDE TO REQUIREMENTS OF SOIL WORKING EQUIPMENT

What has all this to do with agricultural engineering?

Agricultural engineering is responsible for a part of the condition as it exists today. Unless agricultural engineers study plant growth in relation to soil conditions, how can they comprehend the requirements of soil-working equipment?

The elements that make up man's food are many, and these elements can only be derived through plants. Generally speaking, our soils have not been tilled sufficiently to show complete depletion of the various mineral elements necessary, but the surface soil, our seedbed, is rapidly being depleted of these elements. They are not being returned either in commercial fertilizers, or in animal or green manures in sufficient quantities to maintain an equilibrium or soil balance. In fact, many hundreds of samples have been tested in our laboratories, and soils taken from seedbeds of some good farms show a complete deficiency of available rare mineral elements, whereas the rootbed soil, when oxidized, shows an abundance of these elements.

The problem that confronts us as agricultural engineers is one that involves biology, soils, chemistry, and physics.

We must know and understand soils, their physical structure, the action necessary to produce efficient tilth, to so handle the soil that it can and will be at its maximum production condition; then the plant root action in this soil; and finally the replacement of deficient mineral elements in relation to soil particles, as well as the function of humus.

It is easy to say that plants, through their roots, are soup eaters and will take in just the right amount of food and in proper proportions to produce healthy plant structure, but plants have no endocrine organs, they have no intelligence, nor can they move from place to place in search for better conditions. It can be truly said, however, that the inner workings of the plant are about as complicated and unexplainable as those of animals and humans.

What is the function then of the phloem, that tissue forming part of the bundle system concerned with the downward conduction of elaborated sap, or the xylem with the upward movement of sap, or the protoplasm, chromosomes and photosynthesis, functioning in combination with the atmosphere, rays, and moisture, above the soil, and the edaphic influences?

Who can deny that all of this structure is not electrolytically controlled, that osmosis is not electrolysis, and that the soil in which our plants are growing is not a gigantic storage battery, the soil particles the container or filler, the mineral elements the chemical salts, moisture the liquid, humus the separator plates, the roots the conductors to the motor or plant, comprising the cells, membranes, and fibers wherein the elements through radioactive means are transmuted into starches, sugars, and fats.

We know that certain elements are found in plants, the number varying in minor degree. What is the function of these elements? Have not most of them positive or negative charges, and when combined do they not generate electrical energy? If a normal, healthy plant requires these elements, then the soil in which we place the seed and expect it to grow, must also contain them, and these elements must be in condition for plant use, a condition so fine that individual particles can only be measured in microns or millimicrons. This fineness can be produced through oxidation, and I think you will agree that oxidation is a function of electrical activity.

We are all aware of the fact that turning up the subsoil in a field renders that field about as sterile as the Mojave Desert. Undoubtedly the elements are there, but fertility is not. Let it lay fallow for a time, or shall we say, let it become oxidized, and in a year or two, by cultivating or stirring it occasionally, it will begin to take on fertility. Add humus and it becomes a good soil.

THEORY AND PRACTICE OF DEEP TILLAGE

Deep tillage admits oxygen to the rootbed, changing the elements therein to a usable condition through the medium of oxidation. It thereby makes available the essential elements, that the plant through its root system may be continually energized. In the operation of ripping the rootbed, we find such complete fracturing of the soil that the absorption of moisture is extremely rapid, and by the addition of humus, or humus-making material, provides an excellent and efficient water storage from which the plants may be supplied during the dry period of the growing season.

This system of tillage does not interrupt the use of the field. It is best to fracture the soil when it is dry, as the fracture is more complete, and permits more air to enter into the stratum, giving more complete oxidation, as well as opening up more area for water reception. This should be carefully done, following the contours of the field, to assist materially in preventing surface runoff.

An ideal system of deep tillage would place humus in this lower stratum, for we need humus in our soils, and need it badly. Here is an opportunity to design an implement that will supply humus material to the lower stratum during the ripping operation. I have such an implement in mind and hope to have it ready for next spring.

The most practical method of deep tillage is to first rip the soil to a depth of from 18 in to 3 ft, depending upon the root system of the crop to be planted. This ripping action heaves the soil, fracturing the lower stratum to the depth of the blade. The distance between the rips varies from about 20 to 36 in, depending upon the soil structure,

the distance can be set after a few trials by noting the width of fracture.

The next operation should be done with a heavy cover-crop disk, chopping the cover crop into small pieces. If desired, a moldboard plow can next be used to invert the soil, but I question the necessity of this operation. I much prefer a disk plow if a plow is to be used.

Then the jostler, having from four to eight short teeth, about 14 to 18 in long, works the clods and granules to the surface, filling the voids left by the plow and ripper with the finer soil particles. This sequence seems to be the most practical at the present time.

The implements available for this work are crude, yet some day we will awaken to the fact that implements for deep tillage operations are of vital importance and essential to good agricultural practice, and perhaps some thought and study will be given to producing efficient implements for this work. Here is a chance for agricultural engineers to really function. We preach the virtues of the plow to prepare a seedbed, and forget about the all-important functions of the rootbed. The moldboard plow, as it travels through the soil, presses and compacts the surface of the lower stratum, making it almost impervious to moisture, setting up a terrific resistance to root growth, and, in so doing, depriving the plant of energy required for full growth. Then we wonder why our yields are low and our fields move hither and yon by wind and water erosion. What a marvelous opportunity we agricultural engineers have before us to really perform a service to the farmers of America.

But in my opinion, we must know more of the physics of soils, more of the bio-electro-chemical actions taking place therein, and when these various actions and functions are better understood, it would not be at all surprising to see an entirely new type of equipment recommended to the farmer. Perhaps it will be a machine that will drill holes in the soil and place the seed therein. Possibly the lower portion of the penetrating member could be made to expand and contract to fracture the rootbed, or to set up explosions by means of electrical discharges. This ethereal idea is not as far-fetched as it may seem at first, for by so doing we would secure an injection into the soil of O_3 (ozone), and from my own experiments the results are most interesting. This field is practically untouched, except for a little scratching here and there.

In a wheat field in Ohio the poorest portion was deep-tilled in the summer, and wheat planted in the fall. In the low portion of the field, which was supposed to be the best, the soil was plowed and fitted in the conventional way. The result was forty-two bushels in the deep-tilled section, and twenty in the plowed section. In a potato field, also in Ohio, one portion of the field was never known to raise more than 100 bu, but after being properly deep-tilled the yield reached about 200 bu. In my own potato field this year the line of deep tillage was clearly marked by foliage growth at least 6 in taller than that in the portion not deep-tilled.

Let me offer a suggestion that any one may try. Take a block in any field and run the ripper through the soil to a depth of about 20 in, but instead of spacing the rips every 30 in run them about 40 or 60 in apart. Do this in the fall when the soil is dry, then plant wheat or rye, and see the difference in height of the crop in the spring. It will show a stronger stand and will head out earlier than the crop in the center between the rips. I hardly need to add more. The system is logical, and if we are to utilize our soil to the fullest extent and thereby produce healthy plants, and, in turn, healthy food containing all of the elements essential to man, then it is absolutely necessary.

We need science in our agriculture, and when it is applied the managerial type farmer will need the services of an agricultural engineer to explain or interpret the physics of plants and soils. It is true that there has been a vast amount of agricultural research, and many facts have been established, but many more must be discovered.

Experience in the Utilization of Farm Machinery

(Continued from page 60)

it would surely be exposed to dirt. I have already spoken of the part rubber tires play in our moving on the road.

We are prepared to undertake almost any farming operations that we may be called on to do, except two, corn planting and corn cultivating. As you can see, the presence of a large amount of machinery doing custom work in a community which is 55 per cent tenant farmed might give some people the impression that we are out to take over the whole neighborhood. This is not true, as we consider our services as purely auxiliary for those farms where the machinery investment for one reason or another is being kept low. By leaving corn planting and cultivating tools out of our custom equipment, we are able to sidestep requests to take over a complete operation, and can pursue a policy of not working on land that does not have an owner or a tenant living on it. We try to book orders for work fairly well ahead and to leave a wide margin of safety to allow for weather conditions. We have been caught once or twice by weather while picking corn, but I do not know of an instance when the combines have had too much to do. So far we have had a fair profit on the custom work, and, in spite of the headaches it sometimes gives us, we expect to continue it.

I hope that this paper has given some idea of the way at least one user of farm equipment looks at his problems. I think that as more and more dependence is placed on machines, other users will become more and more intolerant of the obvious shortcomings still inherent in many of them. Just at present the tractor division of the industry is making great progress, in which I will *not,* however, include streamlining, cigar lighters, or sex appeal in advertising. It does seem that more of the lessons learned there about protection against dirt, strength of materials, and overall stamina could well be adapted to the equipment invariably associated with the tractors.

To one who looks at the farm machinery industry from the outside, it would seem that most farm tools today are built down to a price, and as has been said so often, you get just about what you pay for. Not enough attention is being paid to the amount they eventually will cost the farmer in the way of lost time and repairs. In fact, I doubt if there is a single manufacturer of a general line of farm machinery who today has information as to the day-by-day performance record of his machines for a complete season. For this reason it may be that some day this Society will take up the problem as a project, with a view toward determining just how much cheaper or more expensive certain operations would be if carried out with better tools than are generally on the market today.

I also hope that I have not given the impression in this paper that my point of view is that of a somewhat idealistic perfectionist. Far from it, it's bread and butter to me.

An Approach to Better Drainage Practice

By I. D. Mayer

BEFORE entering into a discussion of present drainage problems of Indiana, it would probably be desirable to take a backsight upon the drainage history of the region, in order to obtain a clearer picture of the events which have brought about or influenced the existing conditions. By quoting from the report of "Long's Expedition to the Source of St. Peters River in 1823", by W. H. Keating of the University of Pennsylvania, we may obtain a description of a portion of northern Indiana at that time, for example, his description of the conditions near Fort Wayne: "Near to this house we passed the state line which divides Ohio from Indiana. The distance from this to Fort Wayne is 24 miles, without a settlement; the country is so wet that we scarcely saw an acre of land upon which a settlement could be made. We traveled for a couple of miles with our horses wading through water, sometimes to the girth. Having found a small patch of esculent-grass (which from its color is known here by the name of bluegrass), we attempted to stop to pasture our horses, but this we found impossible on account of the immense swarms of mosquitoes and horse flies, which tormented both horses and riders in a manner that excluded all possibility of rest."

Other early settlers reported the prevalence of malarial fever, ague, and kindred diseases, and the general unhealthy condition of the country. They also recorded the high fertility of the soil but noted its unfitness for agricultural uses because of the water on and near the surface. These were the early reports about portions of the state which now, since they have been drained, have the most productive soils.

DIRECT AND INDIRECT BENEFITS OF DRAINAGE

Much of the early drainage was carried out in connection with the construction of roads and railroads but, after the advantages of drainage of these lands for agricultural purposes had been demonstrated, the fertile lands of central and northern Indiana were developed rapidly. During the latter part of the nineteenth and the early part of the twentieth centuries over 20,000 mi of open ditches and over 10,000 mi of tile drains were constructed by organized drainage districts, according to the 1930 census. Very little new work has been done since 1920. These drainage enterprises served over ten million acres, or approximately 44 per cent of the total land area of the state. Most of the artificially drained land is in the northern half of the state and in the valleys of the southwestern part of the state. The capital invested in these enterprises was in excess of 54 million dollars, an average of $5.31 per acre. This investment does not include farm laterals or some of the small, privately constructed outlet ditches.

While these investments were made primarily for the improvement of the agricultural land, the benefits extended far beyond the farms upon which the improvements were made. These areas, which in 1823 were too wet for settlement, are now traversed by hundreds of miles of railroads and highways; towns, schools, and grain elevators dot the countryside; and highly improved farms indicate the productive capacity of the soils.

The community as a whole benefited from the more healthful living conditions, the possibility of better roads, and the opportunities for trade and industry resulting from the increased incomes from the drained agricultural lands. The benefits to the community resulting from drainage are, however, often given little consideration, and consequently the public assumes very little responsibility for the construction or maintenance of drainage facilities. Some urban residents more interested in recreation and the maintenance of wild life than in agriculture, have recommended the abandonment or the destruction of drainage improvements in order to promote their program.

In their enthusiasm for private gain, some of the early promoters of drainage projects did not thoroughly analyze the soil conditions before starting construction. This resulted in the drainage of some soils which were not suited to agricultural production. These enterprises inflicted heavy losses upon the investors and resulted in abandoned land and drainage structures, and unpaid bonds. While such projects were few and the areas relatively small, these failures are frequently cited as disastrous results of drainage. Some of the Kankakee projects in the sandy region have been given wide publicity as expensive failures, and one might be led to believe that all of the Kankakee Valley should be returned to swamps, but there are many acres of fine drained agricultural land in this valley and some of its finest muck lands can be utilized only after thorough drainage.

The early drainage enterprises consisted almost entirely of open ditches to be used as outlets for field laterals. The excavations were made to grade and in accordance with specifications for channel bottom, but little or no attention was given to the sloping of the ditch banks, to the disposal of the spoil, or to the construction of outlets from laterals, to road ditches, or to surface runoff from adjoining fields. Usually no provision was made for maintenance of the channel or the banks. The early drainage laws provided only for the construction of the ditches. Consequently, when several landowners were involved, ditch maintenance was neglected until the repairs were almost equivalent to reconstruction. This not only was an expensive form of ditch maintenance, but nearly always resulted in several years of poor drainage and loss of crops before the ditch cleanout was requested. Complicated legal procedure caused additional delay, frequently of several years, after a cleanout was requested.

PRESENT MAINTENANCE PROBLEMS

Several attempts have been made to adjust the drainage laws so that satisfactory ditch maintenance could be accomplished, but the procedure is still so complicated and cumbersome that the results desired are not obtained. The latest effort, known as the "allotment method" made the county surveyor the ditch supervisor and directed biannual cleanouts by landowners of the district. Each farmer was to be assigned a proportionate section of the ditch to be cleaned out in accordance with stakes set by the county surveyor. It is easy to visualize the complications and difficulties arising from numerous cleanout sections resulting from small land holdings and *(Continued on page 70)*

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Equipment for Maintaining Small Drainage Channels

By D. A. Isler

RECENT YEARS of drought and low farm income have contributed to the neglect of proper maintenance of drainage channels. During the past several years there has been renewed activity in this field aided considerably by emergency public funds. In July 1935 a number of Civilian Conservation Corps camps were allotted to the Bureau of Agricultural Engineering for rehabilitation of organized drainage enterprises. In connection with the work of these camps a drainage maintenance machinery research project was established by the Bureau of Agricultural Engineering in October 1936. This paper presents the observations and new developments resulting from the investigations.

From a preliminary survey of the work of the camps and a study of the cost of excavation by various methods, it was decided that on the larger channels excavation was being done economically with dragline excavators. These machines are suitable for new construction as well as for maintenance work and their widespread use is evidence of satisfactory and economical operation. They are obtainable in a wide range of sizes, with digging buckets as small as ⅜-cu yd capacity for light work. They may be procured mounted either on track layer treads or on motor truck chassis.

There is also an elevator or endless conveyor type of excavator which has been developed in the West for the construction and maintenance of irrigation channels. Within the author's knowledge these machines have not been widely used on drainage channels in the central states.

There are channels, however, where the dragline excavator cannot be used very economically due to the small amount of yardage to be moved or where the job is so small that transportation of a machine to and from the work is a major factor in the cost of the excavation. These ditches are usually short, have a bottom width of 2 to 3 ft, are not more than 5 to 6 ft in depth, and only 20 to 40 cu yd of dirt are removed per 100 ft of length. Ditches of

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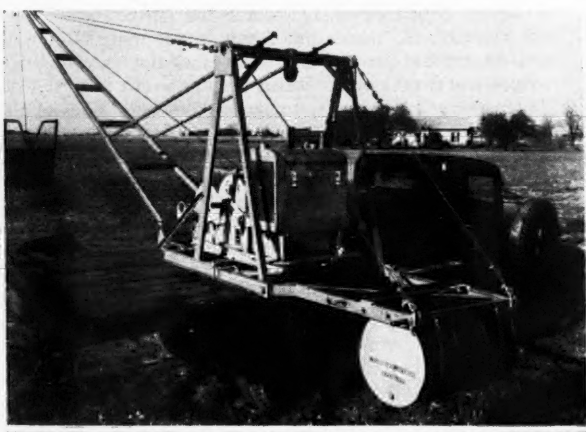


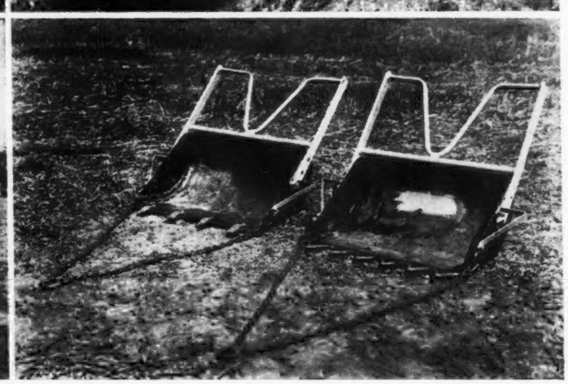

FIG. 1 (UPPER LEFT) TRUCK-MOUNTED SCRAPER EXCAVATOR. FIG. 2 (UPPER RIGHT) SAME UNIT AT WORK. FIG. 3 (LOWER LEFT) UNIT READY FOR TRANSPORT ON HIGHWAY. FIG. 4 (LOWER RIGHT) SCRAPERS USED WITH TRUCK-MOUNTED SCRAPER EXCAVATOR, ONE WITH DRAGLINE BUCKET TYPE TEETH AND ONE WITH TRIANGULAR TOOTHED BLADE

this size were being cleaned by hand, by teams, or by tractors and scrapers, and our efforts have been concentrated on the development of low-cost equipment for use on these smaller channels.

A Truck-Mounted Scraper-Excavator. During the preliminary survey in preparation for the work several rather unusual homemade machines were seen in operation on these smaller ditches. The machines consisted of two winch drums mounted on an old truck chassis and driven through a transmission power take-off or by an old automobile engine. A wood or angle-iron boom extended from one side of the truck out over the center of the ditch. In operation the bottom of the ditch was plowed and the loose dirt removed with a board or backfilling scraper attached to a cable from one of the winch drums. A cable from the other drum worked over a sheave at the outer end of the boom to return the scraper to the ditch for reloading.

In 1936 the board of commissioners of Paulding County, Ohio, with the advice and assistance of F. A. Daum of the Defiance, Ohio, camp, constructed such a machine utilizing a commercial gasoline-engine-driven hoist unit. When this camp started using a side cleaning scraper (used crosswise of the ditch rather than lengthwise) with the machine, a CCC enrollee operator worked out a hookup of the scraper return cable passing through a small pulley attached to the scraper hitch ring, then to the rear of the scraper in such manner as to permit power dumping. This development speeded up the work considerably by eliminating the necessity for the men to follow the loaded scraper up the ditch bank and dump it by hand.

The principle involved in these machines appeared to be a step forward from the use of tractors and development of machines of this type is now being furthered by the Bureau. During the past year three experimental machines have been built by the Bureau and are in use in the field.

A TRUCK-MOUNTED SCRAPER EXCAVATOR

Development work has progressed with the idea that such equipment can be used by ditching contractors and drainage organizations, as well as by the drainage camps. The machine has been designed as a complete attachment which can be mounted on or easily removed from practically any make of truck at least 1½ ton or larger. For light cleanout work where only soft silted-in material is to be removed, the 1½-ton chassis is satisfactory. For all around use, and especially for work in heavy clay soil, a heavier chassis is recommended.

The attachment consists of a double-drum hoist unit, a subframe and standards to support a boom and counterbalance, and a side-cleaning scraper of 5 to 7-cu ft capacity (Figs. 1 and 2). The apparatus is mounted crosswise of the truck bed to permit side cleaning work. A 12 to 18-hp gasoline-engine-driven hoist with a bare drum rope speed of about 100 ft per min has been found satisfactory. The 25-ft boom is supported from one side of the truck at an angle of 25 to 30 deg from the horizontal. It has been found advisable to provide rigid blocking between the rear axle and the truck frame to eliminate spring action and stabilize the truck while at work. The blocking is removable for traveling on highways. Diagonal tie bolts from the frame of the attachment to the main frame members of the truck relieve the truck bed of excessive side strains. The boom is erected into and lowered from working position with power of the hoist unit. The outhaul cable passed over an auxiliary sheave at the top of the boom support framework is utilized for this operation. For highway travel the boom is carried in special brackets at the side of the truck (Fig. 3).

The scraper is similar to those used for tractor work, except that special cutaway handles are provided so that there is no interference with the cables when the scraper is dumped (Fig. 4). A 55-gal drum of water serves as a counterbalance. In winter calcium chloride brine or drained crankcase oil is used.

Cost of the attachment, exclusive of truck, is estimated at $1000. Net weight of the attachment is 3000 to 3500 lb. Tests have shown that the machine will handle 10 to 15 cu yd per hour. In operation the following five-man crew has been used: One truck driver, one hoist operator, two men to guide the scraper while it is being filled, and one grade or utility man.

FURTHER DEVELOPMENT POSSIBILITIES

For commercial use it would be feasible to extend the truck controls so that they would be accessible to the hoist operator. Arrangements for elimination of one motor would reduce the operating cost but such design would involve the use of a special power transmission. Thus far provision for adjustable position and adjustable length boom have not been considered worthy of the additional investment.

This type excavator is superior to tractors in that hand dumping and hand return of scrapers is eliminated. The machine can be easily moved from one job to another. Investment cost is low and construction is not complicated. The truck is usable for regular work by removal of the attachment.

Use of the excavator is limited to the smaller channels. It works to best advantage where the bottom width does not exceed 3 ft; where the depth is not more than 6 ft; and where the quantity excavated does not exceed 40 cu yd per 100 ft of length. When the top width is more than 25 ft, it may be necessary to work from both sides of the ditch. Soft soil conditions may hinder operations especially in muck areas, unless special tracks or mats are provided. There is some danger of overturning a light truck on excessive pulls but, as with any machine, a reliable operator is the most positive safety factor. For work in heavy soils, especially if the ditch is dry, the dirt should first be loosened with a plow.

Since machines of this type have been developed only recently, they have been used thus far only in northern Ohio and northern Indiana, which have flat areas with numerous ditches to which the machine is well adapted. Many of the counties in this area have as much as several hundred miles of ditch on which the machines can be used. At the present time, in addition to the three experimental machines, there are seven or eight privately or county-owned machines of this type in use.

Tractor Excavation. To a considerable extent, tractors have replaced the use of horses on cleanout work. They are used either on direct pull or with drum winches. Investigations for increasing the efficiency of tractor excavation have been conducted on a limited scale, involving principally improvement of scrapers. For tractors equipped with double-drum winches, power haulback of the scrapers is possible through the use of snatch blocks anchored on the opposite side of the ditch from the tractor[1].

Scraper Development. The small drag and side-cleaning scrapers available commercially were developed primarily for use with teams. We *(Continued on page 70)*

[1]Ellison, W. D. Ditch cleaning experiments in Delaware, AGRICULTURAL ENGINEEGING, Vol. 13, No. 8, August 1932, pp. 195-198.

Wall Construction for Air-Conditioned Houses and for Refrigerated Storages

By W. V. Hukill

PRACTICES in constructing insulated walls are continually changing as a result of attempts to take advantage of new knowledge of new types of materials. The use of sawdust and other unprocessed local materials has in large part given way to manufactured products having greater unit resistance to heat flow, as well as having certain structural or other advantages. The relatively recent development of reflective types of insulation furnishes an example of a new material which is taking its place along with the other types and is modifying construction practice.

Aside from the development of new materials and the finding of new knowledge as to application of insulation, there is another reason for continuous changes in insulation practices. This is the constant demand for insulation and insulated walls to serve new purposes. Twenty years ago, or even ten, there were few dwelling houses in which insulation, as we think of it today, was applied. Now many homes are insulated, with the result that certain problems not altogether anticipated have arisen, and new practices are being devised to meet them.

As new methods are worked out and as new problems arise, present types of construction of insulated walls are being modified. It is not the purpose of this paper to summarize the practices which now appear to be best, but rather to call attention to some of the current problems arising from present practices. The principal purpose of insulating material is to retard the flow of heat, and, quite logically, the first scientific studies of insulation were largely measurements of thermal resistance of various materials and various combinations of materials. While there still is and will continue to be need for conductivity measurements on material under various conditions of use, such measurements have been reported over a period of years by a large number of agencies, and it is now possible to calculate the thermal resistance of almost any wall of known construction by reference to a handbook.

MOISTURE ACCUMULATION IN INSULATED WALLS

Probably the most important problem in getting satisfactory results from insulated walls is that of moisture accumulation. Troubles arising from condensed moisture in insulation, which have long been recognized, have received more attention since the practice of insulating dwelling houses has become more or less common. Ice formed from condensation of moisture during very cold weather may accumulate in undesirable quantities and not be noticed. When the weather moderates the ice melts and water appears on interior surfaces, causing discoloration and other nuisances. This condition may occur in tightly built uninsulated houses, but is more common when insulation is used and especially when the inside humidity is artificially maintained at a high level for the comfort or health of the occupants.

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Many insulating materials are hygroscopic by nature, tending to pick up and retain a variable quantity of moisture, depending upon the humidity of the surrounding atmosphere and the nature of the material. Moisture accumulated in this way definitely increases the conductivity of the material. In general such materials, when exposed to given humidity conditions, tend to absorb moisture until a condition of equilibrium exists, and no more moisture is absorbed. The higher the humidity, the higher the moisture content. If the humidity is then reduced, moisture will escape from the material until equilibrium with the lower humidity is reached at a lower moisture content. For this reason hygroscopic materials used for insulation do not necessarily continue to accumulate moisture indefinitely in service, but rather to retain a certain percentage of moisture which increases or decreases according to atmospheric conditions. Hygroscopic materials may tend, under certain conditions, to become somewhat less effective, but the continued accumulation of moisture in insulation does not depend upon the absorptive nature of the material. Such accumulation is the result of actual condensation of water vapor on any part of the wall or insulating material, the temperature of which is at or below the dew point. Any material, regardless of its absorptive nature, will collect moisture when this condition exists. The problem of preventing condensation in a wall may be thought of as one of keeping the dew point of the atmosphere at any place in the wall below the actual temperature at that point.

Normally, there is a temperature difference between the two sides of an insulated wall. If a cross section of the wall is laid out graphically and temperature ordinates are imposed on the cross section, the temperature at all points within the wall at any time can be represented by a line suitably drawn through the section. This is the familiar temperature gradient line. It is also true that in air conditioned houses and many other insulated structures there is normally more water vapor in the air on the warm side of a wall than on the cold side. This amount of water vapor may be expressed in grams per cubic foot, or, in terms of vapor pressure, in inches of mercury. The difference in vapor pressure across the wall tends to cause a transfer of vapor through the wall in the same way that a temperature difference tends to cause a flow of heat, and it is possible to draw a vapor pressure gradient line similar to the familiar temperature gradient line. Since vapor pressure is directly convertible to dew point temperature, the vapor pressure gradient line can readily be translated into a dew point line. This line can then be plotted on the same cross section on which the temperature gradient is shown.

If the temperature and dew point gradient lines be plotted for a wall at a given time, it will immediately be apparent whether condensation is occurring. If the dew point line is below the temperature line throughout the section, there will be no condensation, but if the two lines touch each other, condensation will occur where they touch. It is impossible for the two gradient lines to cross because, when the dew point tends to exceed the actual temperature,

condensation occurs, keeping the dew point and the temperature equal.

The whole problem of preventing accumulation of keeping the dew point gradient line below the temperature gradient line. This may appear to be a rather artificial or academic way of saying that the vapor pressure or humidity within a wall must be kept low to prevent condensation, but it is more than that. It indicates the minimum protection which must be applied. If it were practical to seal a wall against all moisture transfer there would be no point to discussing how little protection can be tolerated, but for most walls a perfect seal cannot be applied economically at present. It is therefore pertinent to consider the limit of tolerance for vapor penetration and this appears to be done most simply by analyzing the temperature and dew point gradient lines.

The thermal conductivity of most materials used in insulated walls is fairly accurately known. This furnishes a basis for plotting the temperature gradient in a given wall under given conditions. To design a wall safe against condensation it is only necessary, then, to adjust the moisture gradients by properly locating barriers to vapor transfer and the sections through which vapor can readily flow.

In general, this means that in walls having the heat flow in one direction during the time when condensation is likely to occur, a relatively good vapor barrier should be placed on the warm side and as little resistance to vapor flow as possible should be left on the cold side. This is beginning to be recognized in current building practice and attempts are being made to perfect vapor barriers especially for use on the inner side of insulated walls of air-conditioned houses in colder climates. In some cases the walls are ventilated to the outside to provide for ready escape of vapor that penetrates the inside barrier. These are steps that tend to eliminate the accumulation of condensed moisture within the wall and have proved effective. The special case when heat flow is periodically reversed, and each side alternately becomes warmer and colder than the other, requires special measures.

MINIMUM TREATMENT FOR MOST ECONOMICAL PROTECTION

So far most attention has been given to developing effective barriers and making adequate provision for escape of moisture, and very little to determining the minimum treatment that will afford protection. Sooner or later, as various protective means are developed and proved effective, the question will arise as to how much attention and expense is justified by necessity and how simple a treatment will answer the purpose. This question cannot be answered satisfactorily until the relative permeability to vapor flow of the various building materials is known with some accuracy. This information is needed for the various structural and insulating materials, as well as for the moisture barriers which may be used. When tables giving vapor permeability of all these materials are as complete as the tables of thermal conductivity are today, it will be a fairly simple matter to describe the dew point gradient through a wall. This can be used, together with the temperature gradient, to determine whether condensation is likely to accumulate under the conditions prevailing. The selection of a vaporproofing treatment can then be made on a basis of lowest cost or other consideration, whereas at present it is necessary to use extreme measures in order to be sure the treatment is effective.

Such measurements as have been mentioned are being made by various agencies, but results are by no means so complete or so familiar to those concerned as, for example, data on thermal conductivity. The U. S. Forest Products Laboratory has made tests of the vapor resistance of various materials and has been able to select some vapor barriers that are highly resistant to the passage of water vapor. On the basis of tests and observations, Teesdale[1] has made some recommendations for treatment and procedure in preventing moisture accumulation.

The condensation of moisture in most insulated structures can be controlled by adequate treatment, and as these treatments are perfected it may mean that many materials not at present considered wholly satisfactory will again come into common use. Local materials or farm by-products such as sawdust or grain hulls have largely been displaced by manufactured products, partly because of the difficulty of avoiding moisture accumulation. If the methods of moisture control being developed prove effective enough, it seems logical that these low cost by-products may again be recognized as satisfactory, at least for farm buildings and in communities where they are available at low cost.

CONSIDERATIONS OF HUMIDITY IN RELATION TO CONDENSATION

When other conditions permit, it is possible to eliminate largely the problem of moisture accumulation by maintaining a low humidity on the warm side of the wall. Other circumstances may require that the wall be exposed to high humidities on the warm side. An example of this condition is in potato storage houses in northern climates. The potatoes are kept at a temperature of about 40 F (degrees Fahrenheit), and in order to avoid undue shrinkage of the tubers a high humidity is desirable. When outside temperatures are low, heat loss through the insulation causes condensation of moisture on the inner surface of the walls and ceiling, as well as within the insulation. Adequate vaporproofing treatment can prevent the vapor from penetrating the insulating material in excessive amounts but does not prevent condensation on the inside surfaces. Special attention is required to prevent damage from such condensation. Moisture collecting on the ceiling surface may drop on the potatoes and start decay, or that condensed at any point may cause damage to structural members. A. D. Edgar of the U. S. Bureau of Agricultural Engineering, in his studies of potato storages in northern climates, has developed a type of structure which permits high humidities inside the storage and at the same time prevents excessive damage from condensed moisture. Mr. Edgar has reported these results to this Society and the recommendations have been incorporated in bulletins available from the Department of Agriculture. In brief, the measures suggested and found effective have been to insulate the ceiling and roof heavily enough so that the inside surface temperatures are higher on the ceiling than on the walls, and any moisture precipitated will be on the side walls. These are protected with water-resistant linings and the condensate drains to the floor where it is carried away without having done any harm. A secondary advantage of retaining the water in the building instead of ventilating to remove excess humidity is that less artificial heat is required to maintain temperature. The amount of ventilation necessary is reduced so that the amount of heat carried off by the circulated air is less, and in addition the heat of vaporization of the moisture is utilized to supply part of the heat loss through the walls when condensation takes place within the building. Special conditions, such as those existing in potato storages, need special study for remedying the difficulties.

[1] "Condensation in Walls and Attics," by L. V. Teesdale. American Builder and Building Age, December, 1937.

We used to think of insulating materials falling into two groups, namely, (1) fibrous material either used as loose fill or in blanket form, and (2) material bonded together in such a way as to be in the form of blocks or panels. Today we have a new type of material not falling in either of these groups. Metallic sheets, which may be very thin, are used to bound air spaces and by virtue of their very high heat reflecting character they constitute a distinct means for reducing heat flow. To be effective the bright surfaces must be exposed to air spaces. The air spaces themselves serve to reduce the amount of heat transferred by conduction and convection, but without reflection surfaces on the sides of a space the amount of heat transmitted by radiation ordinarily makes an airspace relatively ineffective as a heat insulator. This reflective type of insulation has been in use a relatively short time, so that long time observations of its durability and effectiveness have not been available. However, there is now considerable data available on the thermal resistance of air spaces bounded by reflective surfaces, and experience indicates that such surfaces may retain their effectiveness over long periods. The Bureau of Standards has made studies of the effectiveness of aluminum foil insulation[2]. They report that thin layers of dust or very thin layers of lacquer over the foil do not cause very serious changes in the reflective power of foil although thick layers of lacquer may seriously reduce its effectiveness. The principal points on which the available information on reflective insulation is inadequate are as to the various factors that may reduce its effectiveness in service.

DIFFERENTIAL INSULATION BASED ON TEMPERATURE DIFFERENCES THROUGH VARIOUS PARTS OF A WALL

In designing an insulated wall or calculating the heat flow through it, it is customary to start with assumed average or critical inside and outside temperatures to which the wall will be exposed. In most insulated structures all the outside walls are usually insulated alike, the same thickness of insulation being used all around. In some special conditions the prevailing temperature difference between the inside and outside surfaces may be different for each wall. The question then arises as to how much insulation should be applied to the walls having the larger temperature differences. Assuming that unit cost of insulation and its application is the same for all the walls, it can be shown mathematically that the economical way to distribute the insulation is to make the thickness of insulation in each wall proportional to the square root of the temperature difference through that wall. For example, if the temperature difference expected through one wall of a building were 40 F and through another part 10 deg, the difference in the first wall is four times as great as in the second, and the most economical distribution of insulation would be to put twice as much insulation material on the first.

One of the greatest uncertainties in assigning the proper outside temperature is the effect of sunshine. In calculations of heat flow there is at present no accepted, practical way in which the effect of sunshine can be estimated accurately. This effect depends upon the thickness of insulation, the latitude, the season, the orientation of the wall, the normal wind velocity over the wall, the color and nature of the surface, and other factors. To include all the factors in a formula which could be applied for practical use appears to be impossible. Certain arbitrary or empirical methods for estimating solar heat absorption have been used, but with indifferent success. It appears that the most promising basis for these estimates would be experimental observations of the effect of sunshine on exposed surface temperatures rather than measurements of quantities of heat absorbed under various conditions. If the rise in surface temperature due to sunshine is known, the effect on heat flow inward can be calculated. Observations on refrigerator cars indicate that measurements of the effect of sunshine on temperatures of flat black surfaces can be generalized to cover the various latitudes, seasons, and orientation of walls with a fair degree of accuracy for year-round averages. They further indicate that for surfaces other than flat black a fairly constant relation exists between the surface temperature of each color and that of black. For example, if the sunshine intensity and exposure are sufficient to cause a black surface to maintain a temperature 50 F above air temperature, the surface of a certain light color may at the same time be only 25 F above air temperature. If under other conditions the black is 20 F warmer than the air, the white will again be heated about half as much and will be 10 F warmer than the air. This relation which appears to hold fairly well is, of course, complicated by heat capacity of the wall and other factors, but for practical use the establishment of approximate relationship between surfaces of various colors and reflective natures, would assist in establishing a fairly accurate basis for calculating the effect of solar radiation on heat flow into insulated walls.

The U. S. Weather Bureau has, at a number of its stations throughout the country, equipment for recording the intensity of solar radiation continuously. Records from these stations are available and can be used to excellent advantage in establishing a basis for calculating solar heat gains. In addition to this there is a need for studies of the actual amount by which solar heat raises the temperature of various colors and types of surfaces under various exposure conditions. At least three of the state experiment stations are conducting tests of this nature.

J. W. Simons of the U. S. Bureau of Agricultural Engineering and F. B. Lanham of the University of Georgia are carrying on tests at Athens, Georgia, in six one-room and two three-room houses built especially for the purpose and of various types of construction. One of the purposes of these tests is to measure in actual structures the effects of the various factors on absorption of solar heat. However, no final results on this work are yet available.

WALL CONSTRUCTION IN RELATION TO COMFORT

Another question which is closely related to wall construction and about which there is a great deal to be learned is: What are the conditions of temperature, humidity, air movement, and radiation that combine to furnish the most healthful and comfortable environments? Studies of this question have been under way for several years. The American Society of Heating and Ventilating Engineers Research Laboratory at Pittsburgh has contributed extensively to the knowledge especially with respect to comfort. "Zones of comfort," indicating the limits of temperature, humidity, and air motion within which most persons are usually comfortable, have been established. The effects of radiant heat on comfort have perhaps been given less attention than those of the other three factors involved. Studies of the effect of the physical environment on comfort are difficult to interpret, but remarkable progress has been made. Determining the relation of indoor environment to health is even more difficult, but the effects on health of the four factors in physical environment must be known before all the problems in wall construction of air-conditioned houses can even be stated.

[2] "Aluminum Foil Insulation," Letter Circular 465, U. S. Bureau of Standards.

Studies of health as affected by air conditions cannot be carried very far by engineers alone. They must have the help and cooperation of the medical profession. In the past few years this kind of cooperation has increased markedly. It is significant that an increasing number of papers at engineering meetings and in engineering journals are being presented by physicians whose studies of physiology have been recognized as part of the necessary background for establishing sound engineering practices.

As additional demands on insulated walls are made or present requirements modified and as new materials and methods are developed, some of the problems mentioned and other similar ones will lose much of their significance. It is as much the part of the engineer to evaluate the relative importance of current problems as to accumulate the knowledge of his profession and reduce it to practice.

An Approach to Better Drainage Practice

(Continued from page 64)

the differences in the times when farmers would choose to do their cleanout work. Ideas of proper maintenance varied widely among farmers and also among surveyors.

The first and only real examples of complete and proper ditch maintenance have been those of the CCC camps. These demonstrations have been a means of awakening farmers and surveyors to the problems of completely reconditioning drainage ditches, including bank sloping, spoil leveling, and proper structures for laterals and surface runoff.

These CCC camp demonstrations have been of great assistance to the farmers served, but one of the great problems now is to provide some means of reconditioning the remaining ditches, for the camps can work on only a few scattered projects. Then, after the ditches are reconditioned, a program of continuous maintenance should be formulated. Some of the ditches in the early camp projects are already growing up in brush and weeds, and the channels show silting. A workable program of continuous maintenance is one of the great problems which is probably not confined to Indiana.

Along with proper ditch maintenance is the problem of properly handling surface runoff from adjoining fields and highways. Surface runoff causes serious erosion to adjoining fields and also to the ditch banks where the water enters the ditch. This erosion is frequently the source of much of the silting in the ditch channel below. In the past, most drainage work stopped at the ditch bank, but it seems that some of the serious drainage problems arise at some distance from the ditch. In other words, getting the water into the ditch is a part of the problem, as well as handling the water in the ditch.

Problems in connection with maintenance of tile ditches are much the same as those of open ditches, but usually needs for immediate repairs are more evident to the farmers and normally receive attention. The dangers to tile because of erosion of the soil over the tile frequently go unnoticed until the tile is exposed and broken down either by machinery passing over it or by frost action. The problems of inspection, protection, and repair of tile lines and tile outlets should be the responsibility of the owners of the tile and also of the owners of the outlet ditches. It will probably require an extensive educational program to bring farmers, contractors, and surveyors to the performance of continuous maintenance.

While the usual function of the drainage ditch is the removal of excess water from the soil, there have been times when it seemed desirable to retain available moisture in the soil. This has frequently been the case in our lighter soils, particularly mucks, during dry seasons when shallow-rooted crops were being grown. Controlled drainage, regulation of the elevation of the water table by means of control dams in the ditches, has provided a subirrigation system for some crops under some conditions. The questions arising from controlled water tables and the effects upon various crops and soil conditions can not all be answered from available information. Subirrigation by means of controlled drainage appears to offer not only possibilities of increased production but also a form of crop insurance for dry seasons. This practice appears to be particularly adaptable to some of the muck soils and muck crops. Proper regulation of flow of water in the drainage ditches is rapidly becoming one of the important problems of these regions.

These and other problems of the construction, maintenance, and operation of drainage structures are not confined by state lines. The same or similar questions might be raised for other regions. If these problems could be solved so as to have wide adaptations for the benefit of agriculture and so that the best drainage practices could be carried out with a minimum of legal and political interference, a great service would be rendered to the farmers on drained land.

Equipment for Maintaining Small Drainage Channels

(Continued from page 66)

have strengthened these scrapers by the use of steel cutting blades and by providing more substantial handles and hitches. From the experience of the drainage camps the most popular shape of scraper for side cleaning work is one having a rounded bottom with the cutting edge flattened for a distance of 6 to 10 in. This is commonly known as a "crescent" scraper. The rounded bottom permits the scraper to be readily broken out in narrow bottom channels and reduces damage to the ditch banks as the loaded scraper is brought out. The flat cutting edge is essential for proper bank sloping. Digging teeth attached to the cutting edge of the scraper are of considerable aid for work in heavy soils.

Miscellaneous. Frequently channels are choked by willows and other growths of light brush which are difficult to pull by the use of a log chain. A device for pulling such growths out by the roots has been developed. The puller is made of two double channel sections about 30 in long, hinged together at one end forming a vise-like apparatus. In operation the puller is opened up and dropped behind the clump to be pulled. Heat-treated steel teeth set at an angle of 60 deg and extending 6 in below the lower edge of the channel irons penetrate and catch the roots while serrations on the inside flanges of the channels grip the tops when the two free ends of the channel sections are pulled together.

Proper maintenance of drainage channels should include keeping down the heavy weeds, shrubs, and other noxious growths which hasten silt deposition. To render the use of a mower on ditch banks practical, it will be necessary to prepare the banks to fit the machinery to better advantage than exists at present. That is, the slopes should be flattened as much as possible, dressed up smoothly, and stumps and snags removed. The presence of fences, water gates, tile outlets, and lateral ditch entrances will be of considerable hindrance to the use of a mower.

Harvesting and Processing Equipment for Walnuts

By H. B. Walker

CALIFORNIA produces annually an average of 70,000,000 lb of English walnuts on approximately 114,000 acres of bearing trees. For the most part these nuts are marketed through the California Walnut Growers Association, a cooperative organization representing 85 per cent of the growers and over 8,000 separate producers. Walnuts are grown commercially in 45 of California's 58 counties. While approximately 95 per cent of the total walnuts sold in the shell are grown in California, practically all other production is in Oregon. Thus this is distinctly a Pacific Coast crop and one requiring considerable special handling and processing before it is released into regular trade channels.

Walnut trees are not only tall but they have strong lateral branches which give them great spread. The planting is approximately 20 trees per acre. These come into profitable bearing in approximately six years, with full bearing at about sixteen years. The extreme size of the trees necessitates special equipment for the removal of the crop at harvest time. In some areas the nuts are left until the hulls are loosened by natural maturity but in other areas, if allowed to remain this long, the meats darken and impaired quality results. This has led to early harvesting by shaking the nuts from the tree before natural loosening occurs.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Asilomar, Pacific Grove, Calif., June 28, 1938.

Author: Professor and head of the division of agricultural engineering, University of California. Fellow A.S.A.E.

FLOW SHEET FOR A COMPLETE FARM WALNUT DEHYDRATION PLANT EQUIPPED WITH GAS TREATING BINS

To get the nuts from the topmost branches men work on platforms supported by movable towers about 20 ft high. These towers accommodate four to eight men, who with hooked poles, shake the nuts from the branches. Such towers are called shaking towers. The nuts are then picked up from the ground by hand and placed in sacks or boxes to be hauled to the farm processing plant.

The processing which takes place on the ranch will vary, depending upon the locality, nut varieties, and season, but for purposes of illustrating a complete plant, it will be assumed that the nuts have been removed from the trees before the hulls are loosened by natural drying.

At the processing plant the field run nuts are dumped from the receiving platform onto a sorting belt or horizontal conveyor where hand workers take out the field hulled, loose hulled, green cull, and damaged, stick-tight nuts. Most of the nuts, 80 per cent or more, will pass directly from the sorting belt to an inclined elevator, thence to a horizontal conveyor, for delivery into the gassing bins.

In the gassing bins a mixture of air and ethylene gas, ratio 1 to 1000, is circulated about and through the nut mass at controlled temperatures of approximately 70 to 85 F (degrees Fahrenheit) for 75 to 80 hr, with complete ventilation and air change, with new gas mixtures, approximately every 12 hr. This gassing, which is necessary to accelerate the natural metabolism of the nuts for hull loosening, must take place in specially designed bins to control nut mass, temperature, humidity, and ventilation. Naturally the hastened maturity is accompanied by accelerated respiration of the nut, resulting in the production of heat, moisture, and carbon dioxide.

After the gassing is complete the nuts flow from the bins through properly arranged gates onto a horizontal conveyor, and thence by an inclined elevator to a holding bin, or directly to the huller. The loose-hull nuts, which require no gassing, are separated from the stick-tight nuts at the receiving platform and these are placed with the gassed nuts at this point in the plant and all pass through the huller.

The huller picks off and separates the loosened hulls from the nuts, the hulls going to a waste dump while the nuts pass directly to the rotary, squirrel-cage washer. Washing must take place promptly if the hull stains are to be completely removed from the shells.

From the washer the nuts pass to a horizontal conveyor or sorting belt, where hand workers remove the culls and partial stick-tights. It is to this belt that the field hulled nuts, separated from the green stick-tights at the first sorting table, are carried into the flow line by placing on the conveyor or dumping directly onto the shaker. From the sorting table the nuts are carried over a shaker to remove dirt, hulls, trash, etc., and then onto appropriate elevators and horizontal conveyors to the top of the dehydrator. The partial stick-tights taken from the sorting belt may be

classed as culls or again treated by special methods for hull loosening and later returned to the huller for rehulling.

Various types of dehydrators are utilized, but in recent years the stack-type has come into use. This consists of a series of bins, three to four in number, placed one above the other. The wet nuts are introduced into the top bin and passed successively to the lower bin through specially designed grates. Thus the flow of the nuts through the dehydrator is opposite to the direction of flow of the drying air. This brings the driest nuts in contact with the warmest air and the wettest nuts in contact with the cooler air as it passes vertically through the stack and is finally emitted at the top.

Other types of dehydrators normally hold the nuts in fixed masses and alternate the direction of air flow. In some cases rotary driers are used. The nuts entering the dehydrator will contain 25 to 35 per cent of moisture, by weight. Nuts are dried to 8 to 10 per cent moisture (dry weight), and the maximum temperature tolerance during drying is 110 F. In field practice a temperature 105 F for air coming in direct contact with the nuts is considered the optimum maximum.

From the dehydrator the nuts may be sacked out or sent by elevators and conveyors to blending bins, where they are usually held for approximately 200 hr to equalize the moisture through the nuts so that acceptable samples may be obtained. After the normal blending period the nuts are sacked out and delivered to the local cooperative packing plant.

At the packing plant the nuts are weighed and classified and then passed through a vacuum machine to remove the light, shriveled and immature nuts. From here they pass over a sorting table to remove defective nuts before routing them through the scouring and bleaching machine to produce shells of a bright, attractive appearance. Again the nuts pass over a culling table to remove unattractive or dark nuts, from which they go through a spiral grader to separate them into definite commercial sizes known as Baby, Medium and Large. The nuts are then sent to respective bins for external drying. During this routing to the drying bins the nuts are sampled, cracked out, and classified as Diamonds, Emeralds or Suntand. After they are properly conditioned in the drying bins they are carried by conveyors to final inspection tables and into appropriate storage bins where they are held until required for marketing. Before marketing, however, the Diamond grade is branded in special branding machines. All nuts are marketed in sacks showing the grades and quality.

Certain cull nuts and excess shell nuts of regular market grades are sold as shelled nuts. From 25 to 35 million pounds are now shelled annually. These nuts are delivered in sacks from the packing plants or air-conditioned warehouses, and passed through mechanical crackers which are of three types, viz., jaw crackers, modified hammer types, and gyratory. Certain new types of crackers are now being developed in which saws are used.

From the crackers the nuts are delivered to picking tables where women separate the shells from the meats and classify the latter as to marketable grades. About 600 to 700 women are employed in a plant unit and the average output is approximately 35 lb of walnut meats per worker per day. These meats are passed over grading tables and special air draft and vacuum apparatus to remove shells, fiber, and dust before packing in special fiber-board cartons or sealed under vacuum in cans. This processing insures shelled nuts of high quality for the trade according to demand.

Research Viewpoints

(Continued from page 53)

"Research is of many different types. There is ample opportunity for all the agencies, private and public, engaged in research to make valuable contributions, especially if further cooperation can be developed.

"Great sums of money are spent annually by industry and commerce on research. It is estimated that research in industrial laboratories alone involves the expenditure of $100,000,000 a year. Some universities spend 25 per cent of their income on research. Some industrial corporations spend as high as 4 per cent of their gross income on research. The Government spends approximately 2 per cent of its total budget on research. The Government spent in the aggregate for its own research activities and those which it subsidized during the fiscal year 1936-37, $120,000,000, including both regular and emergency expenditures.

"The recruiting, placement, and in-service training of research workers in the Government are, under present conditions, less satisfactory than they should be. The Civil Service system and the management of research personnel might be modified at a number of points with advantage to the Government. Two of these points deserve special mention. The Government would gain in the efficiency of its research agencies if it inaugurated a plan of internship training and if it allowed the assignment of its civil career employees, as it does its military and naval employees, to study from time to time in institutions outside of Washington for the purpose of bringing to governmental agencies the methods and findings of science which are being developed outside of governmental research centers.

"In both Government and industry science can render its unique service to the nation only when research is so organized and conducted as to be absolutely impartial in its discovery and statement of facts.

"The Government has developed a pattern of cooperation with research agencies outside the Government by making contracts for the prosecution of specific research projects with responsible institutions and national organizations.

"It seems feasible to make more extended use than at present of the plan of entering into contracts with national research organizations to take charge of research projects. In order that extension of the contract plan may be realized, the governmental research agencies need to secure from the Congress some latitude in the use of funds.

"The methods of securing the funds necessary for research in the Government can be improved. Clear and explicit statements as to the purposes of research projects should be prepared by research agencies. The equipment of the Bureau of the Budget for the consideration of research proposals should be substantially increased.

RECOMMENDATIONS

"That steps be taken to improve the methods of recruiting research workers for governmental service and to provide more effective in-service training for civil employees of the Government.

"That research within the Government and by nongovernmental agencies which cooperate with the Government be so organized and conducted as to avoid the possibilities of bias through subordination in any way to policy-making and policy-enforcing.

"That research agencies of the Government extend the practice of encouraging decentralized research in institutions not directly related to the Government and by individuals not in its employ."

What Agricultural Engineers Are Doing

FROM THE JOINT NEWS LETTER OF THE U. S. BUREAU OF CHEMISTRY AND SOILS AND THE BUREAU OF AGRICULTURAL ENGINEERING

THE American Engineering Council held its annual meeting in Washington, D. C., January 12 to 14. S. P. Lyle of the Bureau of Agricultural Engineering, president of the American Society of Agricultural Engineers, and L. J. Fletcher, representative of A.S.A.E. on A.E.C. attended the annual banquet.

The District of Columbia section of the A.S.A.E. met on the evening of January 11 for a dinner at which a number of out-of-town guests were entertained and addressed the group.

* * *

On December 14 Secretary Wallace announced that the four regional research laboratories authorized by Congress will be located at Peoria, Ill., New Orleans, La., the Philadelphia, Pa., area, and San Francisco Bay area of California, representing the northern, southern, eastern, and western regions, respectively.

The research to be carried on will have as its objective the development of new and extended outlets and markets for the main surplus agricultural commodities of the country. Basic research on constituents common to agricultural commodities such as starch, cellulose, protein, and oil will be carried on, as well as studies looking toward the possibilities of utilizing the commodities themselves.

The Agricultural Adjustment Act of 1938 authorized the expenditure of four million dollars this fiscal year to establish the laboratories. Plans for the buildings to house the laboratories are under way and construction will be started before the end of the fiscal year.

The directors of the laboratories, as announced by Dr. Henry G. Knight, are: Northern (Peoria, Ill.), O. E. May; southern (New Orleans, La.), D. F. J. Lynch; eastern (Philadelphia, Pa.), P. A. Wells, and western (Albany, Calif.), T. L. Swenson.

* * *

Chas. A. Bennett, of the cotton ginning laboratories, Stoneville, Miss., in company with J. S. Townsend of the Bureau of Plant Industry, spent the week of January 9 in Stillwater, Oklahoma, inspecting the gins belonging to the A. & M. College there and assisting them to get their roller gins into first-class condition.

* * *

George P. Wolf, administrative officer of the Bureau of Agricultural Engineering, has been selected for the position of business manager of the regional research laboratories, at Philadelphia, Pa., and A. P. Aanestad of the administrative staff of the Bureau of Chemistry and Soils for business manager of the Laboratory at Albany, California.

* * *

In connection with the study of methods to abate the smoke nuisance in orchard heating, A. H. Senner has gone to Davis and Riverside, California, to confer with members of the agricultural engineering department of the University of California and to set up field tests for the two types of atomizing burners for orchard heating which have been developed at the Baltimore laboratory. Laboratory tests and preliminary field tests were made at Baltimore.

Contributions Invited

All public service agencies (federal and state) dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

* * *

As a supplement to the observations on change in weight of corn exposed to atmospheric conditions in several states and to determine the necessary relations governing moisture transfer, a series of tests of equilibrium moisture contents at varying temperatures and humidities is being started by Bureau of Agricultural Engineering workers at Arlington Experiment Farm in the cold storage laboratory of the Bureau of Plant Industry. Results of these studies are to be used in connection with Weather Bureau data to predict what moisture contents of corn may be expected under the atmospheric conditions encountered in the various parts of the county.

* * *

J. R. Dodge has gone to Madison, Wisconsin, to work with Max J. LaRock of the University of Wisconsin and Oscar Shivers and Miss Juliette Mayer of this Bureau in obtaining the remaining field data in the comfort studies of Wisconsin farmhouses and in making final arrangements for publication of a bulletin covering these studies. Mr. Dodge will also cooperate with Mr. LaRock in obtaining photographs which may be used in these publications and with Mr. LaRock and J. P. Ditchman of the Illuminating Engineering Society in obtaining photographs to illustrate the bulletin being prepared on Light for the Farm.

* * *

The principles of control of atmospheric moisture in potato storages which A. D. Edgar has worked out in Maine and Michigan were demonstrated by a working model at the Michigan State College Farmers' Week, January 30 to February 3. One side of the model was of glass and by use of ice on the other sides the principles of controlling condensation by allocation of the insulating material was demonstrated.

* * *

As a part of the grain storage work of the Bureau of Agricultural Engineering, a resurvey of corncribs in Minnesota, Iowa, Illinois, and Indiana is now under way. Samples of shelled corn are taken from inside the cribs with a spiral probe, and tested for moisture content, damage, test weight, and other factors to determine change from condition at time of storage. Twenty to twenty-five cribs in each of eleven counties are included in this resurvey. The work under the direction of Dr. H. J. Barre, is being conducted by Thayer Cleaver in Indiana and Illinois and T. R. Connor in Iowa and Minnesota.

* * *

David J. Price, chief of the chemical engineering research division spent several days in early October conferring with Pennsylvania State officials regarding plans for firemen training programs. He also addressed the Pennsylvania State Firemen's Association at Lebanon, Pa., on "A National Program of Dust Explosion and Fire Prevention in Handling, Harvesting, Milling, and Storing of Agricultural Products." On October 5 Dr. Price spoke before a group of business and industrial executives at the Lions' Club in Lebanon, Pa.

Dr. Price attended a meeting in Chicago of the special committee of the National Fire Protection Association designated to prepare a model law for the inspection of rural electrical installations. This committee, consisting of representatives of all interested agencies, prepared a draft to be submitted to the National Fire Protection Association for tentative adoption at the annual meeting in Chicago next May.

* * *

Hylton R. Brown spent the period from October 10 to 19 in Chicago, Kankakee, Ill., and Milwaukee, Wis. In Chicago he conferred with members of the dust explosion hazards committee of the National Fire Protection Association concerning a safety code for the prevention of dust explosions in country grain elevators. He talked with officials of the Corn Products Refining Company and Underwriters' Laboratories in regard to a series of tests to determine effective methods of providing for the prevention of explosion propagation through conveyor lines in industrial plants. In Kankakee Mr. Brown inspected the new corn mill erected by General Foods Corporation, and in Milwaukee he inspected the new corn mill which the Krause Milling Company has recently completed to replace the one destroyed by a dust explosion and fire two years ago. Mr. Brown found that many recommendations made by the Bureau for protection against explosions had been incorporated in the new plant.

Mr. Brown was in New York City October 25 and 26, where he attended a meeting of the American Standards Association committee on conveyors and conveying equipment. Particular attention was given to the preparation of a code covering the safe design, installation, and operation of all types of conveying machinery. He also had a number of conferences with officials of the National Board of Fire Underwriters concerning blower regulations, and the meeting of the dust explosion hazards committee to be held in New York in January. In New York again in early December he attended a meeting of the safety code committee on conveyors and conveying equipment, and meetings of the American Society of Mechanical Engineers. He addressed the Society on "Control of Dust Explosions in Industrial Plants." At Camden, N. J., he inspected plans for new dust-collecting equipment at the RCA plant.

* * *

Harry E. Roethe and Paul W. Edwards spent the period from September 21 to October 26 in *(Continued on page 82)*

Test No. 314 confirms

Reproduced here is a Copy of Report of Official Nebraska Tractor Test No. 314, on the "Caterpillar" Diesel D8 Tractor. Dates of test: November 28 to 30, 1938.

Note that the Diesel D8 produced *15.60 h. p. hours per gallon of fuel* on the belt—and *13.34 h. p. hours per gallon* on the drawbar. Obviously, h. p. hours and fuel price per gallon—not mere fuel pounds per h. p. hour—provide the only valid measures of fuel economy.

The Diesel fuel weighed 7.01 pounds per gallon. Gasoline (70 octane), for example, commonly weighs somewhat less than 6.2 pounds per gallon. Power users purchase fuel *by the gallon,* and pay more per gallon for gasoline than for Diesel fuel. So Test No. 314 dramatically indicates Diesel economy.

Yet it's not on the firm test course—but in the wheat, corn and vegetable fields—where "Caterpillar" Diesel Tractors show their greatest economy. For under actual working conditions, where track efficiency *also* counts, owners of these Diesel tractors save 60% to 80% *on fuel expense alone*—compared to the spark-ignition power replaced!

UNIVERSITY OF NEBRASKA—AGRICULTURAL ENGINEERING DEPARTMENT
AGRICULTURAL COLLEGE, LINCOLN

Copy of Report of Official Tractor Test No. 314
Dates of Test: November 28 to 30, 1938.
Name and model of tractor: *CATERPILLAR DIESEL D-8 (850 R.P.M.)*
Manufacturer: Caterpillar Tractor Company, Peoria, Illinois.
Manufacturer's rating: 97 Drawbar Horsepower Maximum in 2nd gear (standard conditions).

BELT HORSEPOWER TESTS

H. P.	Crank-shaft speed R.P.M.	Fuel Consumption			Water used gal. per hr.	Temp. Deg. F.		Barometer Inches of Mercury
		Gal. per hr.	H.P. hr. per gal.	Lb. per H.P. hr.		Cooling med.	Air	
TESTS B AND C—100% MAXIMUM LOAD—TWO HOURS								
109.64	850	7.029	15.60	0.449	0.000	165	58	28.980
*TEST D—ONE HOUR								
96.46	850	6.083	15.86	0.442	0.000	165	57	28.985
TEST E—VARYING LOAD—TWO HOURS (20 minute runs; last line average)								
96.21	850	6.107	15.75	0.445	—	165	58	—
1.69	931	1.999	0.85	8.290	—	158	57	—
50.44	890	3.971	12.70	0.552	—	160	58	—
105.75	839	6.732	15.71	0.446	—	165	60	—
25.98	911	2.966	8.76	0.800	—	159	58	—
74.21	873	4.960	14.96	0.469	—	162	59	—
59.05	883	4.456	13.25	0.529	0.000	161	58	28.965

DRAWBAR HORSEPOWER TESTS

H.P.	Draw-bar pull pounds	Speed miles per hr.	Crank-shaft speed R.P.M.	Slip on drive wheels %	Fuel Consumption			Water used gal. per hr.	Temp. Deg. F.		Barometer Inches of Mercury
					Gal. per hr.	H.P. hr. per gal.	Lb. per H.P. hr.		Cooling med.	Air	
TESTS F & G—100% MAXIMUM LOAD											
95.27	26,111	1.37	852	4.58	Not Recorded				159	33	28.815
96.37	18,740	1.93	850	2.59	Not Recorded				160	38	28.805
93.81	15,580	2.26	848	2.32	Not Recorded				161	47	28.960
93.85	13,344	2.64	850	1.86	Not Recorded				162	54	28.910
90.61	10,713	3.17	850	1.15	Not Recorded				163	60	28.900
86.87	7,524	4.33	850	0.66	Not Recorded				163	62	28.880
*TEST H—TEN HOURS—Second GEAR											
73.71	14,249	1.94	850	2.06	5.525	13.34	0.525	0.000	158	37	28.890

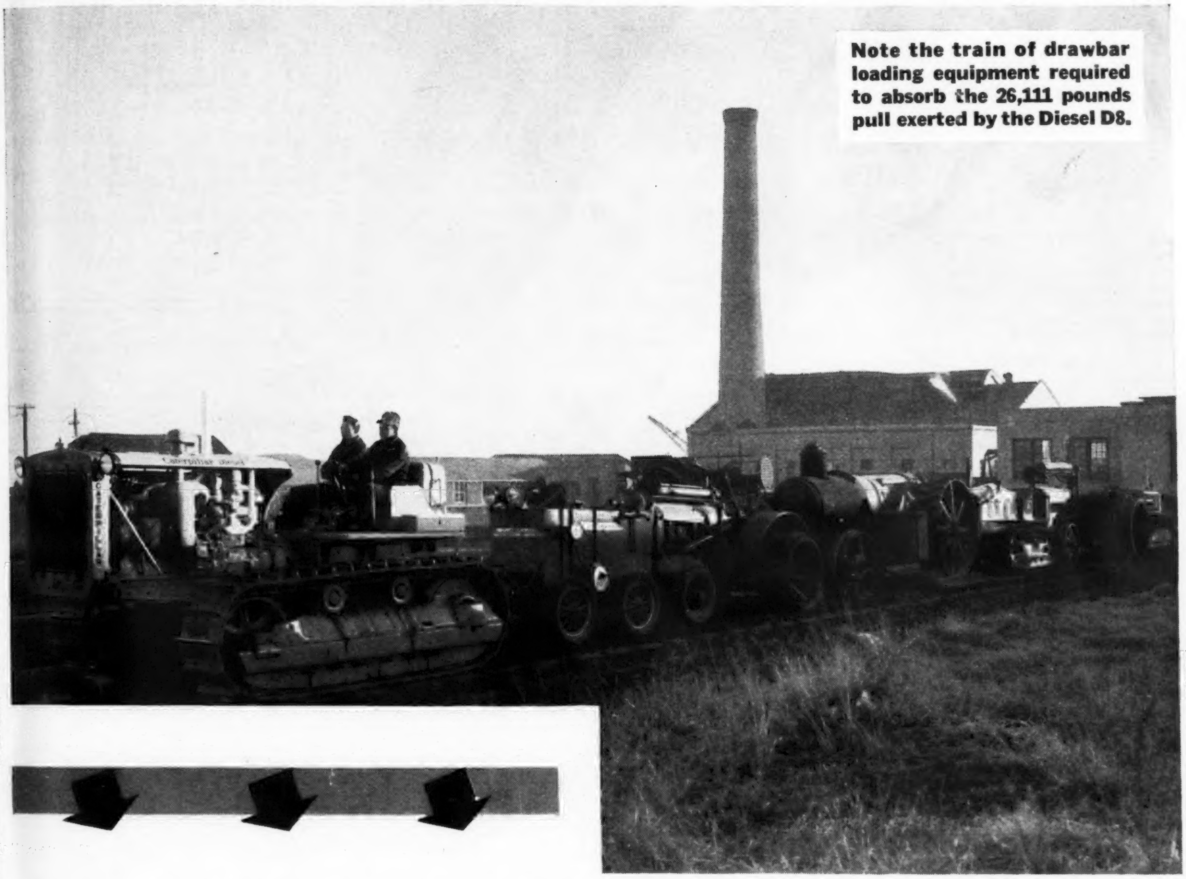
*Formerly called RATED LOAD; see REMARKS 4, page 3.

FUEL, OIL, AND TIME: Fuel: Commercial diesel fuel. Weight per gallon 7.01 pounds. Oil: S. A. E. No. 20. To motor 8.168 gal. Drained from motor 5.505 gal. Total time motor was operated 43 hours.

BRIEF SPECIFICATIONS: Advertised speeds, miles per hour: First 1.4; Second 2.0; Third 2.3; Fourth 2.7; Fifth 3.2; Sixth 4.4; Reverse 1.4-2.3; Belt pulley: Diameter 14½"; Face 13"; R. P. M. 719; Clutch: Make, Own; Type, Single plate, dry; Operated by hand; Seat Upholstered. Total weight as tested (with operator) 32,925 pounds.

MOTOR: Make, Own; Serial No. 1 H 3765 SP; Type, 6 cylinder, vertical, diesel; Head, I; Mounting, Crankshaft lengthwise; Lubrication, Pressure; Bore

owners' experience!



Note the train of drawbar loading equipment required to absorb the 26,111 pounds pull exerted by the Diesel D8.

and stroke, 5¾" x 8"; Rated R. P. M. 850; Port diameter valves: Inlet 2⅛"; Exhaust 2⅛"; Fuel injection system: Own; Serial No. 4P 2423; Governor: Make, Own; Type, Variable-speed, centrifugal; Air Cleaner: Make, Donaldson; Type, Oil-washed, wire-screen filter and collector pre-cleaner.

CHASSIS: Type, Tracklayer; Serial No. 1 H 3765 SP; Drive, Enclosed gear; Tread width, 78"; Measured length of track, 25.3931'; Cleats: Type, Integral with shoes; No. per track, 38; Size 2½" high x 20" long.

REPAIRS AND ADJUSTMENTS: No repairs or adjustments.

REMARKS: 1. All results shown on page 1 of this report were determined from observed data and without allowances, additions, or deductions. Tests B and F were made with fuel pumps set to develop approximately 97 drawbar horsepower maximum in second gear under standard conditions, and data from these tests were used in determining the horsepower to be developed in tests D and H, respectively. Tests C, D, E, G, and H were made with the same setting.

2. Observed maximum horsepower (tests F & B). DRAWBAR 96.37; BELT 109.64.

3. Sea level (calculated) maximum horsepower (based on 60° F. and 29.92" Hg.) DRAWBAR 97.91; BELT 112.93.

4. Seventy-five per cent of calculated maximum drawbar horsepower and eighty-five per cent of calculated maximum belt horsepower (formerly A. S. A. E. and S. A. E. ratings). DRAWBAR 73.43; BELT 95.99.

We, the undersigned, certify that the above is a true and correct report of official tractor test No. 314.

CARLTON L. ZINK, *Engineer-in-charge*. E. E. BRACKETT, C. W. SMITH, L. W. HURLBUT, *Board of Tractor Test Engineers*.

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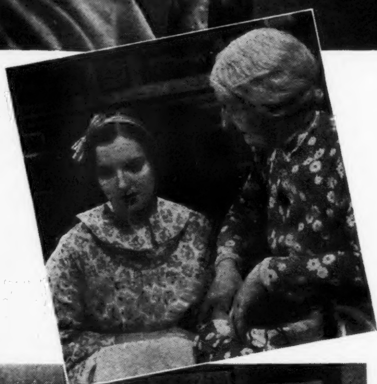

NEWS

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

AMERICAN ENGINEERING COUNCIL'S NINETEENTH ANNUAL ASSEMBLY

OVER one hundred representatives of 53 national, state, and local engineering societies gathered in Washington, D. C., January 12, 13 and 14, 1939, for the Nineteenth Annual Assembly of American Engineering Council. In keeping with Council's policy and purpose, the keynote of the meeting was the serious consideration of the part that the engineering profession should take in public affairs and in the solution of social and economic problems perplexing the Nation. This year's gathering was, in the opinion of impartial observers, marked by a new high in social consciousness and in the determination to procure for the engineer his proper place in social leadership.

As has now become customary, the secretaries of the country's engineering societies, national and local, held their annual conference (the ninth) coincidently with Council's Assembly. Many of the meetings were joint sessions, but the secretaries took time to discuss among themselves ways and means of securing greater efficiency in rendering service to their membership and of making their organizations more effective.

Four broad topics, all of timely interest, were taken up in this way. They were:

1 National Planning and the Engineers' Relation to It.
2 The Economic Status of the Engineering and Kindred Professions.
3 Engineering Aspects of Government Reorganization.
4 Engineering and Economic Factors in the Size of Business.

NATIONAL PLANNING AND THE ENGINEERS' RELATION TO IT

Dr. Harold G. Moulton, president of the Brookings Institution and well-known economist, opened the forum on national planning by declaring his purpose to be, not a discussion of the merits of the subject, but an explanation of what it is. The term "national planning," he continued, carries many connotations, and its meaning varies with different speakers. In the broad sense, the efforts of a governing class to direct policies towards what it considers the future welfare of the nation can be recognized far back in history. The feudal system was one form of national planning; likewise that form of society known as mercantilism.

Today, to most Americans, the term "national planning" implies some substitution of governmental authority for private enterprise. The fact is generally overlooked that our system of private enterprise is, in itself, a form of national planning. As far as governmental efforts at planning are concerned, these have so far been directed entirely at combatting the great weakness of the private enterprise system—the alternate periods of prosperity and depression that constitute the business cycle. And even here, the effort has so far been limited to attempts at "taking up the slack" through economic influence of federal expenditures.

Charles W. Eliot, 2nd, executive officer of the National Resources Committee, delivered the second prepared address on national planning. He reminded his audience that planning is an operation that falls between two others; facts must be gathered first; plans must be executed afterward.

Discussion of this subject brought out a number of points. A. L. Davis (by letter) suggested that the greatest contribution the engineer can make to national planning is to promote the scientific method of approach, based upon facts, and to teach by personal example the value of accepting "the rule of right reason." Roy V. Wright suggested that engineers, as citizens, do all they can to promote the setting up and proper functioning of local planning boards. C. O. Bickelhaupt favored planning for a definite purpose, but stated that the public will not accept planning for planning's sake. F. A. Allner suggested an additional step between fact-finding and planning—the period of interpretation of data. Dr. William McClellan who presided, summed up by remarking that planning is a necessary activity, but it must necessarily be a long-continued process, particularly in a country like this where the idea is new to many citizens. The engineer's part in planning, he said, will depend entirely upon his own initiative, and energy in promoting the idea.

THE ECONOMIC STATUS OF THE PROFESSIONS

Three speakers representing, respectively, the educators, lawyers and architects opened the forum on interprofessional relations.

Speaking as a representative of the teachers, Dr. George F. Zook, president of the American Council on Education, listed as characteristics of a profession the following points: A degree of intellectual attainment, a specialized technique; skill in the practical application of knowledge; high ethical standards; a constant effort to advance the frontiers of knowledge. The true professional man, he declared, places public interest above private personal gain.

The current agitation for socialization of the professions, in Dr. Zook's opinion, is the result not so much of individual transgressions as a part of the general trend toward democratization. The fact is now accepted that many individual actions influence the public welfare.

Turning to professional training, Dr. Zook pointed out that in a society of increasing complexity, the United States is the only highly developed nation that still compresses secondary education into a four-year term. Either our high schools must do a much more efficient job than they have been doing, he predicted, or the course of study must be lengthened by one or two years.

Engineers must realize that they live as members of society, not simply as professional technicians. They need more cultural studies. Medicine and law recognize this by requiring two years of pre-professional collegiate training. Present educational deficiencies are particularly noticeable because of the condensed secondary school term.

The public acceptance of a profession depends primarily upon the efficiency with which it discharges its responsibilities. One important matter is that of admission to the profession, which the public normally leaves to the regulation of the profession itself. Low standards of admission will react to detriment of professional standing.

In presenting the lawyers' viewpoint, Dean William C. Van Vleck, of the George Washington University Law School, also discussed the trend toward socialization of the professions. The current movement, he believes, is motivated by the public effort to procure necessary services, even for those who can ill afford to pay.

Discussion of these three papers brought forth a defense of the present system of engineering education by Dean A. A. Potter of Purdue, who stated that at least one-half of the average curriculum is devoted to non-technical subjects. Furthermore, he stated, the engineering school does not claim to turn out a completed product—its graduates are expected to continue studying after they leave. Attempts on the part of several institutions to establish five or six-year courses have not been successful, and most of them have been abandoned.

Professor Charles F. Scott, past chairman of the Engineers' Council on Professional Development, supported Dean Potter with the remark that the licensing requirement of four years of professional practice is evidence that the engineer does not stop learning after graduation.

In closing the discussion Dr. Zook admitted that the five-year engineering course is an issue of lesser importance in view of the increasing tendency of engineers to return to school for post-graduate work. Regarding Dr. Potter's claim that the curriculum is largely non-technical, he stated that it is common practice to specify non-technical courses along lines allied to technical requirements—resulting in what he termed "segmented" education. What is needed is more study in the line of broad and general education.

ENGINEERING ASPECTS OF GOVERNMENT REORGANIZATION

That the government reorganization bill defeated last year by a narrow margin went down because of a "campaign of misrepresentation" was the *(Continued on page 80)*

ASAE Meetings Calendar

June 19-22, 1939—Annual meeting, University Farm, St. Paul, Minn.

New Officers of Pacific Coast Section

AT THE annual meeting of the Pacific Coast Section of the American Society of Agricultural Engineers held at Davis, California, on January 17, 1939, the following members were unanimously elected to serve as officers of the Section for the ensuing year: Walter W. Weir, chairman; L. J. Smith, first vice-chairman; O. B. Zimmerman, second vice-chairman; Clyde Walker, third vice-chairman; Walter W. Weir, secretary; Ben F. Hagglund, elected member of the executive committee; and Hobart Beresford (chairman), Frank Adams, and G. W. Gosline, as the three members of the Nominating Committee.


2 in 1
LOOK AT any advertisement in Goodyear's big tractor tire campaign to the farmer — and you'll see that it does two jobs at one time.
Not only does it sell the features of Goodyear's great Sure-Grip tractor tire—
It also sells the farmer on the idea of getting a NEW TRACTOR.
Each advertisement proves that the money-savings will go a long way toward paying for the new tractor.
Each advertisement urges the farmer to talk it over now with his tractor and implement dealer.
That's real help for you. Take full advantage of it by knowing all about the Sure-Grip and by specifying this great tire on all your factory orders.
CASH IN on this advertising by specifying Goodyear implement tires as well as Goodyear Sure-Grip tractor tires on all factory orders.
ONLY the GOODYEAR SURE-GRIP provides ALL these advantages
OPEN-CENTER TREAD — no pockets to pack up and cause slip; full self-cleaning; better penetration
WIDER TREAD — greater traction; more pull
BETTER GRIP — lugs are deeper cut and wider spaced to dig in without shearing off soil
SMOOTH RIDING — lug bars overlap evenly at center, giving continuous support on hard roads
GREATER FLEXIBILITY — conforms better to rough ground
REENFORCED LUGS — buttressed at both sides to prevent undercutting
WEATHERPROOF RUBBER — resists effects of sun, weather and barnyard acids
SUPERTWIST CORD in every ply
GOODYEAR FARM RADIO NEWS
over NBC blue network, 1:15 P.M. E.S.T.–12:15 C.S.T.–immediately following the widely popular National Farm & Home Hour. Programs feature information of local interest—news about crop conditions, commodity prices, shipping, weather forecasts, etc. Broadcasts daily Monday through Friday. Tune in!
Specify
GOODYEAR
TRACTOR AND IMPLEMENT TIRES

Washington News Letter

(Continued from page 78)

theme of Dr. Joseph Pratt Harris, director of research for the President's Committee on Administrative Management. Because of this campaign the public has many false impressions about the proposal and the term "government reorganization" now bears unpleasant connotations.

E. J. Stocking, technical examiner for the Civil Service Commission, was the other speaker at this session. Because reorganization is still an active political question and thus barred from discussion by a government employee, Mr. Stocking limited his talk to a description of the present method of recruiting engineers for federal service.

The Commission, he declared, has tried many types of examinations and questions. The present tendency is toward greater use of written examinations, particularly for the higher technical positions. The Commission, he declared, is constantly trying to improve its procedure and welcomes constructive criticism and suggestions.

Roy V. Wright remarked that although no one wants to see the return of the spoils system, it is generally felt that the present Civil Service set-up is ineffective and must be improved.

Continuing along this line, Dr. William McClellan pointed out that the Civil Service Commission cannot function as does private industry in selecting personnel. It must continually resist political pressure, and as a means of resistance it must adopt rigid rules and adhere to them. Regarding reorganization, he reminded the audience that the function of comptrolling, accounting and auditing are separate operations that should be performed independently.

Council Secretary F. M. Feiker reminded members that the Council has actively cooperated with the Civil Service Commission in its studies on technical personnel, and Mr. Stocking confirmed this statement.

FACTORS IN THE SIZE OF BUSINESS

The fourth and final forum session considered the topic "Engineering and Economic Factors in the Size of Business", with Dr. Willard Thorp, director of economic research for Dun and Bradstreet, as the speaker. Dr. Thorp first presented a series of charts depicting graphically the part which large corporations play in the present economic picture and then drew from them certain conclusions. He found, for example, that large corporations normally have some, at least, large competitors; that in only a few cases do large enterprises stand alone in their field. Another conclusion was that there is a greater concentration of assets than of employees and that the "labor problem," considered as a relationship between management and large groups of employees, is limited to a relatively small proportion of companies.

L. J. Fletcher remarked that "business is judgment in action." Goods are not sold, he claimed, but are bought. Because the seller is organized and the buyer is not, the former claims the credit for the transaction. But so long as business popularity is determined by the votes of buyers there is no call for worry about the size of business enterprises.

THE ENGINEER AS AN ECONOMIST

Another feature of the Assembly was a talk by Dean Dexter S. Kimball of Cornell, past president of Council, before a dinner meeting of the Conference of Secretaries, on the subject "The Engineer as an Economist." Whether he likes it or not, said Dean Kimball, the engineer is being forced more and more to deal with economic problems. In his work he has already displayed an outstanding ability to go beyond strictly technical duties; about 75 per cent of the engineering graduates engage in some form of administrative work. His qualifications for these duties include knowledge of the scientific method, familiarity with industrial methods, ability to get along with labor and a reputation for honesty.

ALL ENGINEERS' DINNER

The outstanding event of the meeting was, as usual, the All-Engineers' Dinner, at which Dr. Vannevar Bush, the new president of the Carnegie Institution of Washington, delivered a stirring address on the present and potential place of the engineer in the social fabric and the factors upon which these depend. He said in part:

"Engineering . . . derived jointly from the quiet cloisters of science; and from the turmoil and strife of aggressive business, and it is no wonder, therefore, that it should wabble a bit as it seeks to evolve its own professional philosophy.

"But does it matter after all? Are the things that engineers do so vital that they must needs be approached in the professional spirit? Most certainly it matters. And most certainly the task is a professional one. The impact of science is making a new world, and the engineer is in the forefront of the remaking. He lights the way in a very literal sense. He brings peoples close together for better or worse, by facile communication and rapid transportation. He guards the food supply, and replaces the hopelessness of Malthus with an embarrassing plenty. He shortens the hours of labor, and fills the consequent leisure with distractions. He temporarily disrupts the techniques of whole industries, and thus alters the life habits of many people, in maintaining a continually rising standard of living. He bores through the earth and under the sea, and flies above the cloud. He builds great cities, and builds also the means whereby they may be destroyed. Certainly there was never a profession that more truly needed the professional spirit, if the welfare of man is to be preserved.

"The focus of this whole affair is the American Engineering Council. More than any other group it represents the engineering profession as a whole, in its relationships with government, other professions, and the public. Here, more than in any other organization reside the external as contrasted with the internal relationships of the profession. It was founded by men who considered its functions in terms of a high idealism. It is now going through a strenuous period of self-examination. To this every individual can contribute only one set of thoughts to be merged with all of those which seethe, and interact, out of which will come in due time that consensus which will form the opinions, traditions, codes, consciousness which will mould the engineering profession. It will come unless the Council fails; for if it fails, and if its place is not taken by a more rugged successor, there will be no unitary engineering profession at all. In the spirit of adding my few thoughts to those of the eminent men who are directing the Council I have previously offered comments, and I now comment again, with the expectation that I will be disagreed with and answered, with the wish to add my mite to the consummation.

"I find it a vigorous and rapidly evolving body. I consider it to be utterly inadequately supported by the profession as a whole, in comparison with the central bodies of sister professions, and with a serious problem as to how adequate support can be drawn for the great task that lies ahead of it. I find it partaking of the great American tendency toward overcomplication, and inclined to attempt things which seem to me personally to be off the main beat. I find to my great joy that it gradually is becoming known and recognized; and I trust this is just a beginning. I find it with that greatest of assets, a devoted, energetic and high-minded executive secretary; guided by some of the best minds in the profession as its officers, who are giving valuable time to its cause; and I hence cannot fail to be optimistic as to its future.

"To me, however, there is just one point on which I wish to focus attention. I find it struggling with its own philosophy. I find, in fact, that it hesitates as it formulates its idealism; that it has not yet placed its foot unequivocally and irrevocably upon the path that leads to complete devotion to the public welfare. I find that it has not yet enunciated its belief that the great mission of the engineer lies in intelligent, aggressive, devoted ministration to the people. This I urge with all the emphasis I can command."

THE BUSINESS SESSION

Inspired, at least in part, by the close juxtaposition of Dr. Bush's urge toward greater service to the public and the necessity of again adopting a depression budget, the principal topic in the business session of the Assembly (aside from the consideration of committee reports) was the financial status of Council. President William McClellan pointed out forcefully, that with an overworked staff, Council is constantly having forced upon it problems that are not optional, but that must be taken care of if the engineering profession is to discharge its obligation to the public welfare. If Council, under its present setup, is unable properly to discharge these obligations it must either be recognized or some other body will take its place.

Additional membership seems the only solution to this problem. It was recognized that all engineering societies now have serious financial problems and that a number of potential applicants for membership in Council are holding back solely for financial reasons. The proposal was advanced that a new membership class be set up for individuals. It was also pointed out that many belonging to member societies are not fully aware of the importance of Council's activities, and that more efforts must be made to bring home to them the results obtained from their financial contributions.

The work of the committee on public affairs in developing the forum idea was greatly commended. Applications are now in hand from a number of local organizations who would like to participate in this program. Here, again, the financial situation exercises restraint. It was pointed out that the original purpose of Council was to demonstrate the feasibility of the forum idea, not to embark on a long-term program.

The recent grant of $22,500 by the National Industrial Conference Board to finance a special study under the direction of Council's subcommittee on patents was cited as an example of the recognition of Council's high standing by an outside body.

The terms of only three officers expired this year, and all were re-elected. They were Carroll O. Bickelhaupt and John S. Dodds as vice-presidents and Leonard J. Fletcher as treasurer.

What Agricultural Engineers Are Doing

(Continued from page 73)

an extensive investigation of fires in cotton gins. Their itinerary included Arkansas, Texas, Louisiana, Mississippi, and Georgia, where they visited approximately 60 cotton gins and cottonseed warehouses. They interviewed state insurance commissioners, fire marshals, fire department chiefs, officials of rating and inspection bureaus, officials and staff members of cotton gin companies, insurance companies, and ginners' associations. They collected data upon which to base a study of this important subject.

Mr. Roethe attended the annual meeting of the Farm Fire Protection Committee in Chicago, November 29. The State Fire Marshals' Section of the National Fire Protection Association met in Chicago the same week, and Mr. Roethe had a number of conferences with the state fire marshals from Nebraska, West Virginia, Iowa, Illinois, and Indiana. He is a member of the American Society of Agricultural Engineers and assisted that society in revising the report "Farm Fire Prevention and Control." Before returning to Washington he visited a number of points in Wisconsin where he conferred with several persons on spontaneous heating of hay, motorized fire apparatus, electric fencing, and lightning protection systems.

* * *

G. A. Cumings, in charge of fertilizer placement studies, Bureau of Agricultural Engineering, reports that the principal conclusions from the cooperative studies on fertilizer placement with white beans in Michigan, were (1) fertilizer placed in the furrow with the seed (a farm practice) reduced the stand and failed to produce increased yields, (2) placement of the fertilizer in a band 1.5 in deeper than the seed, either directly under or 1.5 in to the side produced the largest yield increases. Special Bulletin No. 296 has recently been published by the Michigan Station on this subject.

* * *

On January 5, R. B. Gray, chief of the division of mechanical equipment, delivered a paper entitled "Some Considerations in the Use of Rubber-Tired Machinery on the Orchard and Farm" at the annual meeting of the Maryland State Horticultural Society at Frederick. Much interest was manifested in the use of rubber tires. One grower stated he had two 20-hp tractors each equipped with rubber tires of different make. When No. 1 tractor got stuck he could always pull it out with tractor No. 2, but the latter could pull more at the drawbar in normal going.

* * *

A motor-driven, recording-type soil penetrometer has been constructed at the Tillage Machinery Laboratory at Auburn, Alabama, which shows considerable promise as a device for measuring the compactness of various soils. Tests are contemplated with this device to determine the comparative packing of soils by wheels of different types.

* * *

Several representatives of the Cleveland Tractor Company recently visited the Tillage Machinery Laboratory on matters pertaining to tillage problems of the southeastern states.

* * *

Messrs. Godtel and Reaves of the Allis-Chalmers Manufacturing Company visited the Tillage Machinery Laboratory where they inspected the testing equipment and discussed problems of cotton and sugar cane machinery with the men at the laboratory.

* * *

For the first time a single-seed-ball beet planter, designed and built by E. M. Mervine at Fort Collins, was used this year on a commercial basis. Results, just computed, show that this planter yielded 24 per cent more single beet plants than the standard planter. These results are significant and are encouraging enough to make "mechanical thinning" of beets look practical.

* * *

Electricity has been suggested by some for possible use in killing weeds. In cooperation with the Utah State Agricultural College, E. M. Dieffenbach of the Bureau of Agricultural Engineering, is setting up some preliminary experiments to determine whether plants with extensive rootstalks, such as the most troublesome perennial weeds, can be killed with electric current.

* * *

A series of laboratory tests is being conducted at Davis, Calif., to determine the uniformity of seed distribution of single-seed-ball and conventional sugar-beet planters. The seed dropped by each planter as it is pulled along a runway is caught on boards covered with a thin coating of light cup grease. This has proved a very effective means of overcoming any bouncing or rolling of the seed as the balls are held at the exact point of drop and their positions can be accurately determined.

Authors

Henry Giese is author of "Iowa's Rural Fire Waste Problem," reporting results from project 23 of the Iowa Agricultural Experiment Station, published in and reprinted from the Proceedings of the 58th annual meeting of the Iowa Association of Mutual Insurance Associations.

E. R. Gross tells how to build "A Septic Tank Disposal System" in New Jersey Agricultural Experiment Station Circular 381.

Wheeler McMillen recently addressed the Boston Advertising Club on the economic significance of Chemurgy. The title of his address was "Plenty for Everybody."

C. N. Turner describes "A Shallow-Well Water System" in Cornell Extension Bulletin 392.

F. D. Yung has reported on "A Portable Milk Cooling Cabinet" in Agricultural Engineering Progress Report No. 5, a three-page mimeograph of the Nebraska Agricultural Experiment Station.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Henry H. DeLong, instructor and research assistant, South Dakota State College, Brookings, S. D. (Mail) 421 12 Avenue.

W. A. Junnila, investigator, Washington C.R.E.A., Washington State College, Pullman, Wash.

Henry B. McDonald, engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 171, Americus, Ga.

W. H. Park, manager, Commercial, Industrial and Agricultural Electrical Sales, Pacific Gas & Electric Co., 245 Market Street, San Francisco, Calif.

W. R. Peterson, farmer, Claremont, Minn.

L. John Schilling, agricultural engineer, research department, Babson Brothers. (Mail) 7330 Ogden Avenue, Riverside, Ill.

Reuben O. Schlegelmilch, graduate assistant, department of agricultural engineering, College of Agriculture, Rutgers University, New Brunswick, N. J. (Mail) 17 Handy Street.

Robert F. Skelton, graduate assistant, agricultural engineering department, University of Illinois, Urbana, Ill. (Mail) 706 S. Gregory Place.

Albert Vosti, mechanical engineer, Box 121, Gonzales, Calif.

TRANSFER OF GRADE

J. W. Carpenter, agricultural engineer, Caterpillar Tractor Company, Peoria, Ill. (Mail) 200 North University. (Member to Fellow)

Student Branch News

OHIO

At a meeting of the Ohio Student Branch of Agricultural Engineers December 1st, a committee was appointed to prepare the annual report to the Farm Equipment Institute. Plans were also made for taking a group picture to be placed in the Makio, which is the official yearbook of the University.

Following the meeting, John Younger, chairman of the department of industrial engineering, gave an interesting and educational discussion of "The Wage and Hour System" as applied in modern industries.

The Student Branch presented C. O. Reed with a pipe during his recent illness and expressed the well wishes of the group.

At the December 15 meeting, Ralph Patterson was elected as a new member to the Engineer's Council. Harris Gitlin was elected as alternate. After the meeting, because of difficulty students have experienced in making out schedules, T. G. Watson, Secretary of the College of Agriculture, led an interesting and informative discussion on schedules and how they should be filled out.

At the January 5 meeting, the first meeting of the new year, President Gordon Royle announced the new committees for the quarter. Plans were made to enter a booth at the All-Ag Carnival to be held January 21. Following the meeting three students gave interesting and educational talks on their work as combine service men, during the summer, for a leading farm equipment company. Fred Yoder reported on types of training schools and his experience in the training school of one farm equipment company.

At the last meeting, January 19th, it was suggested that the Student Branch give a demonstration in the use of the slide rule to the students of the College of Agriculture. By this time plans for the Farmers' Week lunch counter were well under way and it was urged that everybody help in setting up the lunch counter and with the work during Farmers' Week. The lunch counter is being relocated and reorganized to increase its efficiency.

Following this meeting, motion pictures taken by the four delegates to the A.S.A.E. meeting at Asilomar, California were shown and accompanied by a description of the meeting and 7500-mile trip.

—Publications Committee.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted may be addressed to the publisher thereof or to AGRICULTURAL ENGINEERING

A PRELIMINARY STUDY OF THE EFFECT OF CULTIVATION ON CERTAIN CHEMICAL AND PHYSICAL PROPERTIES OF SOME SOUTH DAKOTA SOILS, *L. F. Puhr and O. Olson*. South Dakota Sta. Bul. 314 (1937), pp. 31, figs. 8. "Structural stability of aggregates . . . was found to be the same in virgin and in cultivated soils, but cultivated soils showed a tendency toward more rapid slaking in water than did virgin soils.

"Losses in humus and loss on ignition occurred in the cultivated soils in every case. . . . An average loss of 42 per cent of the original organic matter resulted from cultivation in the soils which were studied. With such large losses of organic matter changes in structure would be anticipated. Since marked changes in structure were not found, it appears that while organic matter may be necessary in the development and maintenance of favorable structure, its value diminishes after the soil has acquired sufficient organic matter for the development of maximal structure. In the virgin soils, the larger amounts of organic matter were probably responsible for the increased time of slaking.

"The mechanical analyses showed that little change in the texture of the soils has been brought about by cultivation. In three clay soils studied, a slight increase in the $\frac{\text{sand} + \text{silt}}{\text{clay}}$ ratio resulted. All other soils showing slight decreases in the $\frac{\text{sand} + \text{silt}}{\text{clay}}$ ratios of the cultivated soils.

"Cultivation resulted in a decrease in base exchange capacity in all soils studied with the exception of two. Since these two represent relatively small increases as compared with the decreases, it may be that original differences in the soil were responsible for the apparent discrepancy. Decreases in base exchange capacity were found to correspond closely with decreases in organic matter.

"Losses in nitrogen were found in all cases. The average loss for the eight cultivated soils was found to be 29 per cent of the original nitrogen content. The $\frac{\text{organic matter}}{\text{nitrogen}}$ ratio was found to be decreased by cultivation, indicating a higher concentration of nitrogen in the organic matter of cultivated soils.

"The phosphorus content of three soils was increased through cultivation. Decreases resulted in all other cultivated soils studied. In general, the eastern South Dakota soils decreased in phosphorus content as the result of cultivation.

"The pH of western South Dakota soils was increased, while that of eastern South Dakota soils was decreased, as the result of cultivation."

CHANGE IN MINERAL COMPOSITION OF THE TOMATO PLANT IRRADIATED WITH A QUARTZ-MERCURY VAPOR LAMP AND ITS RELATION TO THE LEVEL AND RATIO OF CALCIUM AND PHOSPHORUS IN THE NUTRITIVE MEDIUM, *W. D. Stewart and J. M. Arthur*. Contrib. Boyce Thompson Inst., 9 (1937), No. 2, pp. 105-120, fig. 1. "Tomato plants were grown outside, in the greenhouse, and under shading cloth on fractional solution cultures. The plants were alternated at 24-hr intervals between McMurtrey's 'complete minus phosphorus or calcium' solutions and single salt solutions containing calcium or phosphorus or both. Rate of supply of calcium and phosphorus and ratio of calcium to phosphorus were varied. The plants were grown 4–6 weeks on these solutions and their response to irradiation under a quartz-mercury vapor lamp as reflected by change in ash, phosphorus, and calcium content observed. Results from the data are summarized [as follows]: (1) Plants grown on solutions lacking calcium or phosphorus showed no increase in ash, calcium, or phosphorus on irradiation. (2) Level of supply of calcium or phosphorus and not ratio of calcium to phosphorus determines presence or absence of response to irradiation. Without altering the ratio of calcium to phosphorus (high ratios), presence or absence of response was secured by controlling the rate of solution renewal. (3) Plants grown on solutions deficient in phosphorus (low renewal rate) were high in ash. Increase in the concentration of phosphorus of the solution lowered the ash content. (4) Decreasing light intensity during the summer increased dry weight, ash, and phosphorus content but decreased calcium. (5) On solutions deficient in phosphorus (high ratio of calcium to phosphorus) the response to irradiation was increase in ash and calcium, whereas on solutions deficient in calcium (high phosphorus-low calcium) the response was increase in ash and phosphorus. With intermediate values for ratios of calcium to phosphorus the response was increase in ash, calcium, and phosphorus. (6) A reciprocal relationship between calcium and phosphorus was observed. (7) Phosphoric acid at concentrations of 1 p. p. m. was an excellent source of phosphorus for the tomato plant."

RELATION OF STABLE ENVIRONMENT TO MILK PRODUCTION, *M. A. R. Kelley and I. W. Rupel*. U. S. Dept. Agr., Tech. Bul. 591 (1937), pp. 60, figs. 21. The investigations reported in this bulletin were conducted at Genesee Depot, Wis., during the winters of 1930-31 and 1931-32 in cooperation with the Wisconsin Experiment Station. A large barn divided into four sections, each housing 22 cows, was used during both winters of the study, and during the last winter an open stable housing 8 cows was added to the test. Three of the test stables were held at constant different temperature levels, while the fourth section and also the open stable were allowed to fluctuate with the weather about as under usual herd management. Uniform lots of cows were stabled under the different temperature conditions, with all other environmental factors being held as uniform as possible. The extensive data presented indicate how different temperature levels, sudden changes in temperature, and drafts affect milk and butterfat production, water consumption, live weight, pulse, respiration, body temperature, and health of the cows.

The optimum barn temperature under the conditions of this trial appeared to be about 50 F.

SOME EFFECTS OF DIFFERENT STORAGE TEMPERATURES ON THE KEEPING OF CRANBERRIES, *R. C. Wright, J. B. Demaree, and M. S. Wilcox*. Amer. Soc. Hort. Sci. Proc., 33 (1936), pp. 397-401, figs. 2. Of various temperatures from 30 to 70 F, tested by the U. S. Department of Agriculture for the keeping of cranberries, 36 F proved most suitable for preserving the berries of the Early Black and Howes varieties in a marketable condition for both 2 and 4-mo periods. At the end of 4 mo there were 65 and 73 per cent, respectively, of marketable fruits in the two varieties. Below 36 F there was a marked decrease in decay, but low temperature break-down became a serious factor. Berries were most attractive at 36 and 40 F, but above 36 there was a tendency for the berries to increase in color to an undesirable degree. The various rots associated with cranberry losses in storage are listed.

THE RESPONSE OF STRAWBERRIES TO IRRIGATION IN A DRY HARVEST SEASON, *F. E. Staebner*. Amer. Soc. Hort. Sci. Proc., 33 (1936), pp. 349-354, figs. 6. In this study, conducted cooperatively by the U. S. Department of Agriculture and the University of Maryland in a commercial berry field on the eastern shore of Maryland with six varieties—Blakemore, Catskill, Dorsett, Fairfax, Premier, and Big Joe—fine responses in yield were obtained from irrigation during the extremely dry harvest period. The drought became so intense that it was necessary to water the control plants to save them. Determination of soil moisture, made on samples collected from the various nonirrigated plats, showed that moisture under the plants spaced 11 in was as low as under matted plats, indicating that in a dry period the spaced plants take up all the available moisture. However, the best moisture conditions were found under irrigation where the plants were spaced 11 in and the maximum water was applied. Under the conditions of the experiment the maximum beneficial amount of water was not reached in any plat, possibly because irrigation was not begun early enough or possibly because excessive transpiration resulted from the hot, dry winds. (*Continued on page 86*)

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THE LOSS OF CAROTENE IN HAYS AND ALFALFA MEAL DURING STORAGE, *E. A. Kane, H. G. Wiseman, and C. A. Cary.* Jour. Agr. Res. [U. S.], 55 (1937), No. 11 pp. 837-847. Studies were conducted by the U. S. D. A. Bureau of Dairy Industry regarding the carotene losses in alfalfa, timothy, and clover hays and alfalfa meals of different degrees of fineness during storage at varying temperatures. Baled alfalfa stored in dark, unheated barn lofts at temperatures of 7.2 C or less, from 7.2 to 18.9 C, and above 18.9 C lost carotene at average rates of 2.6, 6.6, and 17.8 per cent per month, respectively. Baled timothy stored at 7.2 C or less and at from 7.2 to 17.8 C sustained carotene losses of 4.3 and 6.2 per cent per month, respectively, and losses in clover hay stored at an average temperature of 11.1 C averaged 6.3 per cent per month. Alfalfa meals ground to pass through 1/8, 1/4, and 3/4-in mesh screens lost carotene at the same rate during storage regardless of the degree of fineness and at practically the same rate as corresponding samples of baled hay. The carotene disappeared about three times as rapidly as the natural green color of the hay or meal.

A MULTIPLE PIPETTING MACHINE, *W. N. Plastridge and L. F. Williams.* Jour. Lab. and Clin. Med., 23 (1937), No. 3, pp. 318-320, figs. 2. The setting up of the serological tubes with the proper amount of antigen suspension in the application of the tube agglutination test for the diagnosis of Bang's disease in cattle and pullorum disease in poultry having become an economic problem in many laboratories, a mechanical pipetting machine capable of filling 140 tubes per minute was devised for the purpose at the [Connecticut] Storrs Experiment Station. A description and plans are given for its construction, at a reasonable cost.

HOUSING AND HOUSEHOLD EQUIPMENT [AT THE BUREAU OF HOME ECONOMICS]. U. S. Dept. Agr., Bur. Home Econ. Rpt. 1937, pp. 13, 14. This progress report includes data on the cost of cooking with electricity, kerosene, gasoline, manufactured and bottled gas, and on an accelerated life test carried out on two ice-cooled cabinets and two electric refrigerators.

SOIL EROSION IN OHIO, *G. W. Conrey, J. S. Cutler, and A. H. Paschall.* Ohio Sta. Bul. 589 (1937), pp. 32, figs. 10, map 1. This bulletin is designed to present the extent of the erosion problem in Ohio and to point out, in a general way, the relationship of erosion to land use. A generalized erosion map of the state made in connection with a national reconnaissance erosion survey of the United States is included. The map was compiled under the direction of the U.S.D.A. Soil Conservation Service, with the cooperation of the Bureau of Chemistry and Soils and the station.

As a result of studies made in Soil Conservation Service project areas and Civilian Conservation Corps camp areas, as well as cooperative studies made by the station and the U.S.D.A. Bureau of Agricultural Economics and Soil Conservation Service, it has been established that all sloping lands in Ohio fall into four main classes where land use is concerned. These are: (1) Those lands which may be cultivated under normal tillage conditions with minimum soil loss by erosion, (2) those lands which may be cultivated if special soil-conserving measures are used, (3) those lands which should be kept permanently in grass or grass-legume cover in order to prevent erosion, and (4) those lands so steep that they should be kept under permanent shrub or tree cover if erosion is to be controlled. The slope percentages to be included in these various land-use classes vary with the soil areas.

THE EFFECT OF FERTILIZER PLACEMENTS AND ANALYSES ON THE GROWTH AND YIELD OF CERTAIN TRUCK CROPS, *M. M. Parker.* Amer. Soc. Hort. Sci. Proc., 33 (1936), pp. 474-477, figs. 2. At the Virginia Truck Experiment Station, an experiment was conducted in 1936 to compare the effectiveness of increasing amounts of potash and phosphorus in fertilizer mixtures applied in various positions with relation to the seed or plants.

In the case of snap beans, where potash-containing materials were placed in wide bands beneath the seed the higher the potash content the lower was the germination and the smaller the yield. Yields obtained from side placement of materials containing 5 and 10 per cent potash were slightly lower than those from broadcast applications. From greenhouse studies it was apparent that bands of fertilizer may restrict root development and interfere with soil moisture utilization during dry periods. With phosphorus, injury resulted from placement beneath the seed, but to a very slight degree with band placement along the rows. Broadcasting gave somewhat better yields than band placement. The best yields were obtained from mixtures containing 6 per cent phosphorus and 5 per cent potash. Yields were low when no phosphorus was included in the mixture.

In the case of cabbage, mixing the fertilizer with the soil in the row before setting the plants gave higher yields than did the application in bands beside the row. Where fertilizer was mixed into the soil in the row, a 5 per cent potash gave maximum yields, but when placed in bands 10 per cent was most effective. The response to phosphorus was more marked, irrespective of the type of placement, than was the response to potash.

THE COOL STORAGE OF PEACHES: IN AIR AND ARTIFICIAL ATMOSPHERES, *F. E. Huelin, G. B. Tindale, and S. A. Trout.* Jour. Dept. Agr. Victoria, 35 (1937), No. 12, pp. 609-614. Investigations at the Government Cool Stores in Melbourne, Australia, showed that for the successful keeping of peaches the fruit should be picked when showing a considerable amount of blush but still firm and stored promptly at 32 F. In ordinary air, the average storage life was about 6 weeks, while in artificial atmospheres containing from 8 to 10 per cent of carbon dioxide the period could be lengthened by about 50 per cent. Following storage, peaches must be transferred to 65 F or thereabouts, for adequate ripening.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE IDAHO STATION, *H. Beresford.* Idaho Sta. Bul. 225 (1938), pp. 15-20. A brief historical review is given of investigations in irrigation, land reclamation, power and machinery, rural electrification, farm buildings and equipment, and waste utilization.

MAKING LIME ON THE FARM, *N. A. Kessler.* Coop. Ky., Mich., Penn., Va., and W. Va. Expt. Stas. et al. U. S. Dept. Agr., Farmers' Bul. 1801 (1938), pp. [2] + 21, figs. 8. This deals with factors which should be considered by a farmer or a group of farmers before investing in equipment for obtaining lime from limestone or marl. It discusses especially the quarrying, grinding, and burning of limestone and the digging of marl.

ELECTRIC BROODING OF CHICKS.—II, HEAT REQUIREMENTS, *W. T. Ackerman, T. B. Charles, C. M. Foulkrod, A. E. Tepper, and R. C. Durgin.* New Hampshire Sta. Bul. 303 (1938), pp. 31, figs. 15. Further experiments on electric brooding are reported which dealt with heat requirements. During the subsequent years of 1935, 1936, and 1937 the following subjects were added to the study: (1) Floor insulation, (2) labor and fuel costs for coal v. electric brooding, (3) application of heat under brooder, (4) relation of house floor area to brooder size, (5) prevention of floor drafts, (6) extended brooding period, (7) effects of power ventilation, (8) chick movement, and (9) physiological needs of chicks.

A summary of the 4 years' work indicated that electric brooding is practical and can be carried on under very severe climatic conditions without auxiliary heat or excessive mortality. Necessary high cost of application and lack of value from the insulation of walls and ceilings in houses used for electric brooding indicate its use to be unwarranted. Although the results of tests indicate that 1 in of insulation enclosed in a waterproof bag and placed between two layers of wood is the point of diminishing returns from floor insulation, there is nothing to indicate that a double wood floor with a disk of 1-in insulation board or its equivalent, properly waterproofed and slightly larger than the brooder, placed on the floor under the brooder will not be just as good as, or slightly better than, built-in insulation, and is certainly less expensive. A comparison of labor and fuel costs for coal and electric brooders indicates very little cost differential between the two methods.

Under cold weather brooding, when litter changes are necessary, it is recommended that the new supply be preheated before being placed in the pens. Increasing the square area and cubic contents of a brooder by the addition of extension rims and extra curtain, without changing the chick load or heating element, was of material benefit in stabilizing temperature control under the brooder. It is important to establish values for air exchange under the various types of electric brooders.

No difficulties in the management of chicks were encountered in a prolonged brooding period of 14 weeks as long as the cockerels were separated from pullets at 6 weeks of age, thus reducing the number of chicks approximately one-half and compensating for their increased size. The main irregularities in the temperature under brooders are obviously caused by brooder design features, floor drafts, and chick movement. It is recommended that no more than 200 baby chicks be placed under a 52-in square electric brooder and not more than 225 chicks under a 56-in round electric brooder. Loadings of baby chicks under electric brooders higher than those mentioned above were a direct cause of high mortality. *(Continued on page 88)*

International Harvester ANNOUNCES A 70 H.P. DIESEL TRACTRACTOR

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STUDY OF RURAL HOUSING, *D. G. Carter.* Arkansas Sta. Bul. 364 (1938), pp. 31, figs. 12. This bulletin presents an analysis of results obtained in a study of more than 200 farm homes, located in 67 counties of Arkansas, and which were built with a contribution of home labor and local material resources.

A positive correlation was found between family size and house size and between annual income and expenditure for housing, and the proportion of home labor used decreased as the cash expenditure increased. Labor and material costs based upon typical commercial construction were divided, 37.5 per cent for labor and 62.5 per cent for material.

Literature Received

"THE ENGINEERS' MANUAL," by Ralph G. Hudson. Second edition, IV + 340 pages, 5x8x⅜ in. A pocket-size compilation of engineering formulas, mathematical operations, and tables of constants most commonly used; arranged in order of derivation. Each formula is accompanied by a statement of its applications, involved physical quantities, and units of measurement. The book is designed to save time for the practicing engineer in making calculations and obtaining data not kept fresh in his memory by frequent use, and for the student in summarizing important relations which may be derived from fundamental principles. Data on heat, electricity, physical constants, steam tables, and conversion factors have been brought up to date and amplified since publication of the first edition. Sections deal with mathematics, mechanics, hydraulics, heat, electricity, and mathematical tables. Indexed. John Wiley and Sons, $2.75.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

JUNIOR ENGINEER. The U. S. Civil Service Commission announces an assembled open competitive examination for junior professional assistants, including engineering as one optional branch. Applications must be on file with the commission at Washington, D. C., not later than February 27, or for those mailed from any of several named states in the far West, March 2. Application form 8, copies of which may be obtained at any first-class post office, should be used in filing application for this examination. In the examination 50 per cent of the weight will be placed on engineering fundamentals and 50 per cent on the optional subject chosen. Applicants must have successfully completed a full 4-year course leading to a bachelor's degree in engineering, in a college or university of recognized standing or be senior students in such courses. Other usual Civil Service examination regulations apply. More detailed information is given in the Commissions announcement No. 18, dated January 30, 1939.

POSITIONS WANTED

AGRICULTURAL AND CHEMICAL ENGINEER with master's degree in agricultural engineering. Eight years' experience in agricultural engineering teaching and research. Three years' experience in chemical industry. Desires position in teaching or research. Age 35. Married. PW-299

AGRICULTURAL ENGINEER, graduated in June 1938 and six months' experience with farm machinery manufacturer training for sales work, desires position in sales or in work which may lead to sales. Best references. Unmarried. Will go anywhere. Age 24. PW-300

AGRICULTURAL ENGINEER, graduate of Virginia Polytechnic Institute, desires employment where past experience will be of value in future work. Has farm background, two years' experience as an assistant county agent in soil conservation, and engineer in charge of a terracing unit. Has had considerable experience in contacting and working with farmers. Past experience mainly with extension division work, machinery, and erosion control practices. Can furnish best of references. Age 24. Single. PW-301